Fig. 55. A drawing of a section showing the position, structure, and nerve-supply of the opercular organ of *Eutrochatella pulchella*.
Fig. 56. A portion of the epithelium of the hypobranchial gland of *Alcadia hollandi*. Highly magnified.
Fig. 57. A left lateral tooth from the radula of *Eutrochatella pulchella*. Highly magnified.
Fig. 58. Radular teeth of *Alcadia hollandi*, highly magnified: *a*, median; *b*, *c*, *d*, first, second, and third admedians of the left side; *f*, one of the marginals or uncini; *e*, a lateral tooth of the right side showing the stalk, *stk.*, the aliform internal plate, *al.p.*, the articular excavation, *art.*, and the process, *ext.p.*
Fig. 59. Three rows of teeth from the radula of *Lucidella aureola*. In this and the following figures only the proximal members of the marginals are indicated.
Fig. 60. Two rows of teeth from the radula of *Palæohelicina idæ*.
Fig. 61. Two rows of teeth from the radula of *Orobophana pachystoma ponsonbyi*.
Fig. 62. Two rows of teeth from the radula of *Aphanoconia gouldiana*.
Fig. 63. Two rows of teeth from the radula of *Aphanoconia andamanica*.
Fig. 64. Two rows of teeth from the radula of *Aphanoconia merguiensis*.
Fig. 65. Two rows of teeth from the radula of *Aphanoconia rogersii*.
Fig. 66. Shell of *Aphanoconia rogersii*.
Fig. 67. Shell of the same species, showing the aperture.
Fig. 68. Shell of the same species, viewed from above.
Fig. 69. Operculum of *Aphanoconia rogersii*, viewed from the inner or ventral side.

36. On the Palatability of some British Insects, with Notes on the Significance of Mimetic Resemblances. By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Society's Gardens and Curator of Mammals. With Notes upon the Experiments. By Prof. E. B. Poulton, F.R.S., F.Z.S.

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Introduction.

At the request of Prof. E. B. Poulton, F.R.S., I undertook, in the summer of 1909 and again in that of 1910 *, to make a series of experiments in the Zoological Gardens to test the palatability of various species of British Insects. Much of the material was sent to me by Dr. G. B. Longstaff from Morthoe in Devonshire. Some I received from Prof. Poulton himself or from friends of his. A few species I added on my own account; notably the stick insects and the ants, of which we had an abundant supply in the Insect House in the Gardens. Those that I supplied I identified myself. The rest were in all cases named by the senders. To the insects Dr. Longstaff added a number of slugs, which were identified, I understand, by Mrs. Longstaff.

Since the majority of the experiments were made with English Insects, it is regrettable that English, or at all events Palæarctic birds, were, for the most part, unavailable for the tests. There were two reasons for this. In the first place, Palæarctic insectivorous birds were not strongly represented in the Society's

* Records of a few experiments made in 1911 have been incorporated in the text.

collection. In the second place, those that were in the Zoological Gardens at the time were, in most cases, kept in a very large flight aviary with plenty of cover in the way of shrubs, representing their natural environment as nearly as possible. Never having been tamed by confinement in small cages, they were too shy to come to the bars to take insects from my hand and too scared to notice them if I entered the aviary. Once or twice I tried the experiment of liberating butterflies in this aviary; but the frequency with which they escaped through the wire mesh and were wasted for the purpose in hand, induced me to abandon further experiments of that kind.

This reference to the shyness of birds in captivity brings me to another of the limitations under which I was working. I was forced to restrict my attention to particular birds, tame enough either to take insects directly from me or sufficiently accustomed to the presence of human beings in the aviary to capture liberated insects in spite of my close proximity. If I put the insects through the bars, myself standing outside, they were either seized one after another by the boldest bird in the place, or were carried by a timid bird to the back of the compartment, where I could not watch what befell them. I was compelled, therefore, to be inside the bars. Since, moreover, it was practically impossible to watch more than one bird at a time, I was precluded from the method of experimenting with the shyer specimens by giving insects to the bolder ones to distract and monopolize their attention. Thus it comes about that the same species appear over and over again in the experiments below recorded, while many insectivorous birds, that might have been tried but for their shyness, are omitted.

Two facts struck me very forcibly at an early stage of the experiments. The first was the exceeding keenness of the birds for the insects brought to them. This was no doubt due in a measure to our inability in the Gardens to feed the birds on living insects other than mealworms. The living prey was evidently a great treat to them; and over and over again I was impressed with the persistence shown by birds in persevering with insects that were obviously not to their liking, returning to the morsels repeatedly as if food of such a nature was too good to be wasted. From this I think it may be inferred that in a state of nature hungry birds will eat nauseous insects which in times of plenty they will reject after tasting, or will not take the trouble to catch them if they have previously learnt their distastefulness by experience. Furthermore, it is quite clear that the plain record of an insect being eaten is no proof of its palatability. Better evidence on this head is supplied by the behaviour of the bird towards it. After a little experience in this matter, I was able to satisfy myself at all events as to the approximate correctness of my interpretation of the bird's actions, and to judge thereby of the comparative palatability of the insects they tasted.

The second fact has an important bearing upon the criticism sometimes advanced against the theory of warning coloration and mimicry as applied to butterflies, namely, that birds under natural conditions are seldom seen to eat these insects.* Hence it has been inferred that birds cannot be reckoned as serious enemies of butterflies. Whatever may be the explanation of the circumstance, I am tolerably sure, from the behaviour of the two classes of animals when pitted against one another, that the inference drawn therefrom is erroneous. The insectivorous birds in our aviaries seemed to know at once what the butterflies were; they were on the alert the moment one was liberated and pursued it with determination and precision, following its every turn and twist, and either catching it upon the wing or pouncing upon it after settling. It is true that this predatory deftness may have been acquired in relation to the chase of insects other than Lepidoptera; but unless the birds recognised butterflies in general—a group which cannot be mistaken for other insects—as part of their natural prey, it is difficult to understand their eager excitement at the sight of those I offered them.

Again, unless the species of butterflies used for the experiments are, or were in the past, habitually preyed upon by birds, whence comes the extraordinary skill the liberated specimens, when undamaged or inexhausted by confinement, displayed in dodging the swoop of the birds in mid-air? Having repeatedly seen the aim of the pursuing bird baffled by the evasive twist of the butterfly, I cannot doubt that the insect's behaviour was prompted by the instinct to escape an habitual enemy of its species, of the same class and with the same predatory methods. It cannot, I imagine, be seriously claimed that escape from the upleap of insectivorous mammals, lizards, or frogs has been a factor of sufficient importance in survival to be reckoned with in this connection; and, *a fortiori*, the modernness of the invention of the entomologist's net puts this instrument of capture out of court for consideration. The evidence, therefore, seems to me to afford the strongest support to the conclusion that the power to dodge in mid-air and the instinct to put it in force have been fostered to subserve no other purpose than the evasion of swift-winged insectivorous foes. Perhaps predatory Pompilidæ must be regarded as a possible auxiliary influence; but apart from these hymenoptera, I can think of no enemies but birds likely to have persecuted butterflies on the wing to the extent presumably necessary to have guided their evasive tactics to the pitch of proficiency they now exhibit.

Whatever be the value of this suggested explanation of the facts, the facts themselves remain as I have stated them:—(1) Caged insectivorous birds which, so far as is known, have never been fed in captivity upon butterflies, are at once excited by

* Twice I have seen sparrows, which are not typically insectivorous, chase white butterflies in London. Two birds acting in concert were successful on the first occasion; one single-handed failed on the second occasion.

their appearance, chase them with eager speed, catch them in mid-air with precision, and eat them or taste them with avidity. (2) Pursued butterflies when overtaken often avoid the birds, not once only but twice or three times, by sudden turns up or down to right or left.

Those who hold, on the negative evidence above stated, that birds are not to be reckoned as serious enemies of butterflies, must be called upon to supply some explanation other than that above proposed of the marked reactions between these two classes of animals when brought into contact with one another, and to show reason why what takes place in the aviary may not be regarded as indicative of similar occurrences in nature.

With regard to the experiments on mimicry, especially those made with *Volucella bombylans* and *Bombus hortorum*, it appears to me that they satisfy all that the theory, as propounded by Bates, demands. They fully confirm Prof. Lloyd Morgan's experiments on birds, with the drone-fly (*Eristalis*) and the honey-bee (*Apis mellifica*), as well as those with the banded and uncoloured slips of glass holding respectively meal adulterated with quinine and meal untampered with.* They show that several species of birds, after learning by experimental tasting that *Bombus hortorum* is unpalatable, refused to touch *Volucella bombylans*.

Other items of interest that may be briefly alluded to are the experiment demonstrating, at least in the instance tried, the attractive nature of the ocelli on the wings of the peacock butterfly (*Vanessa io*); the experiments showing that *Formica rufa* is not protected from mammals and birds by its acid taste; that the black members of the Carabidæ and *Ocypus olens* are unpalatable to the ground-feeding mammals they were offered to; that *Coccinella 7-punctata* and the Telephorid beetle (? *Rhagonyche fulva*)—belonging to families of beetles which are common objects of mimicry in the tropics—are distasteful to nearly all mammals and birds.

At the end of the part of the paper describing the experiments made, I have added, at Dr. Longstaff's suggestion, for the information of those unfamiliar with the habits and distribution of the mammals, birds, and reptiles to which the insects and other invertebrates were offered, a list of the species of the former groups giving a few particulars on those points.

Finally I have to thank Prof. Poulton for kindly annotating the paper before it went to press, and for explaining more fully than I could do the bearing of some of the results on the theories of mimicry and of the connection between palatability and coloration. I am also indebted to Commander J. J. Walker, R.N., for kindly giving me the scientific names of the Lepidoptera.

* Animal Behaviour, pp. 164–165, 1900.

The Experiments

MOLLUSCA.

(Slugs.)

Large Black Slug (*Arion ater*).

Sept. 24, 1910. Two taken and eagerly eaten by two Meerkats, who wiped them down with their paws and rubbed them in the sand apparently to remove the slime.

Oct. 26, 1909. One given to Black-winged Grackle was eaten.

One (larger specimen) given to the same bird was abandoned; offered to Sulphury Tyrant, but the bird would not touch it; offered to Sun-Bittern, was pecked, but not eaten; carried to a perch by Harmonious Shrike-Thrush but was soon dropped; pecked and shaken about, and much hammered by Abbot's Rail, which managed to break the skin of the slug and getting at the inside ate a large portion, but would not eat the outside.

One taken by Dial Bird which persevered for a long time, hammering and wiping it in the sand; he was then driven off by Black-chinned Laughing Thrush, which held the slug in his foot and ate little pieces of the inside after breaking the skin, but left the bulk of it.

Dial Bird tried another, but gave it up.

Common Hangnest took one, but left it after a few pecks.

Two offered to Kagu, a kind of Crane or large Rail, were swallowed entire with very little delay.

One tried by Black-tailed Water-hen which, however, gave it up; the same specimen given to Leach's Laughing Kingfisher was ultimately swallowed entire after being dropped many times.

Arion hortensis.

(Olive-brown Slug with orange-coloured foot.)

Oct. 26, 1909. One eaten by Yellow crowned Hangnest.

Two eaten by Dial Bird.

Two refused by Harmonious Shrike-Thrush.

One twice taken from my hand by Harmonious Shrike-Thrush and dropped both times; but after taking it the third time the bird ate it.

Limax maximus.

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was tried, but abandoned after one or two pecks. It was then taken and eaten by a Black-winged Grackle after a great deal of wiping of the bill.

Sept. 24, 1910. Two specimens tasted by Green Lizard, and Black-spotted Lizard, but not eaten. The Lizards apparently disliked the slime, because they wiped their mouths on the stones after tasting. Both eaten without delay by Glass Snake.

Limax agrestis.

Sept. 24, 1910. One eaten after a good deal of pecking about in the sand by White-crested Jay-Thrush.
Two eaten by a Shama.
One eaten by Kagu.
Tasted but rejected by Fantailed Flycatcher.
Tasted on two occasions by Hoopoe but rejected.
Tasted by Red-vented Bulbul but rejected.
Tasted but rejected by Yellow Hangnest.
Two taken, but not eaten, by Harmonious Shrike-Thrush.
Two taken, but not eaten, by Cuban Mocking Bird.

Limax arborum.

Sept. 24, 1910. Four eagerly eaten by Wall Lizards, which wiped their mouths to remove the slime after swallowing them.

Milax sowerbyi.

Sept. 24, 1910. One taken and pecked and wiped about in the sand for a long time by Indian Dial Bird, which finally left it.
Another specimen was eagerly taken by Sulphury Tyrant, which after pecking and crunching it in his beak, and banging it from side to side against a ledge, exactly as Laughing and other Kingfishers do, finally swallowed it whole.

ARACHNIDA.

Opiliones (Long-legged Spiders or Harvestmen).

Phalangium sp.?

Sept. 1910. One (immature) tasted but immediately rejected by Pekin Robin; the same specimen then taken and eaten by hen Scarlet Tanager.
One (immature) put into cage with several Curassows was tasted in turn by specimens of Yarrell's and the Globose, and ultimately eaten by one of the Globose Curassows, when crushed beyond all recognition.

I was led to suppose these Arachnida would prove on experiment to be unpalatable owing to their possessing a pair of glands, one on each side of the dorsal area of the carapace, which are known to secrete an odorous fluid. As elsewhere recorded *, I have seen a Mason Wasp, hunting Spiders, run down a specimen of *Phalangium*, but turn aside and let it go unhurt the moment he touched it with his antennæ. More experiments with birds and lizards are required fully to substantiate my belief; but the refusal of the Pekin Robin to eat the *Phalangium* is very significant, and it is quite evident that the Arachnid was not to the liking of the Curassows.

* Journ. Linn. Soc., Zool. xxx. p. 268, 1909.

INSECTA.

Order **LEPIDOPTERA.**

Butterflies.

Group PIERINÆ.

The Small White (*Pieris rapæ*).

July 31, 1909. One male (dead) given to Capuchin (*Cebus* sp. *a*) was taken at once, and eaten without being removed from the mouth for inspection. This specimen, given with *Euchloë cardamines* (see p. 820), was used as a check upon the behaviour of the monkey towards *Euchelia jacobææ* and *Melitæa artemis* (pp. 825 and 832).

Sept. 6, 1910. One offered to a Red-handed Marmoset was inspected, but not touched; but was eagerly taken and eaten by another animal of the same species. This Marmoset then ate a specimen of *Perarge megæra*, his behaviour suggesting that the two butterflies were equally palatable to him.

May 26, 1909. One chased at once by Shrike-Thrush and Dial Bird, but evaded them and escaped through the partition into next cage, where it was promptly caught on the wing by a Fantailed Flycatcher and eaten.

One caught at once on wing by Great Tit and eaten.

Aug. 21 to 27, 1910. One greedily eaten by cock Silver Pheasant.

One let loose in aviary skilfully dodged the swoop both of a Shama and a Wood-Swallow, and escaped.

One given to Dial Bird, which took it from my hands and damaged it by the peck so that it was unable to fly away. Again and again he pecked the butterfly as it fluttered about on the ground, but would not hold it. Ultimately it escaped under the partition into the next aviary, where it was pounced upon by a Weaver, which held it in his foot and ate it, leaving the wings.

Sept. 6, 1910. One taken by Masked Wood-Swallow and eaten after much delay and pecking. The bird evidently was not very keen on the insect; but he would not allow any other bird to take it from him. He did not once shake his head or wipe his beak as if there was any distasteful flavour.

One female taken and eaten by Ludwig's Bustard.

Sept. 7, 1910. One male and one female taken and eaten eagerly and with equal avidity by Green Lizard.

Larva of the Small White (*P. rapæ*), fed on cabbage.

Sept. 21, 1910. One tasted but rejected by Yarrell's Curassow and Globose Curassow.

The Green-veined White (*Pieris napi*).

July 31, 1909. One offered to White-tailed Mongoose, to three

Meerkats and to two Banded Mongooses. All rejected it after smelling it except the second Banded Mongoose, which took it with his paw, rubbed it in the sawdust, but would not eat it.

N.B.—The forceps with which this butterfly was offered had been previously used for *Ocypus olens*, *Carabus violaceus*, *Pterostichus niger* and *P. madidus*, and some *Timarchæ* as well as *Coccinella*, and probably the scent of these beetles was adhering to the steel.

May 26, 1909. One taken and eaten by Dial Bird, by Harmonious Shrike-Thrush, and by Blue Rock-Thrush.

July 26, 1909. One male given to Silver Pheasant, was taken from my fingers and swallowed instantly without being first deposited on the ground.

One female given to same bird was treated in exactly the same way.

These two I used as checks upon two specimens of *Melanargia galathea*, both of which the Pheasant treated very differently, spitting them out upon the ground after taking them from my fingers, and pecking them about a great deal before swallowing them (p. 827).

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird ate at the same time a specimen of *Epinephele jurtina*, showing an equal liking for both.

One male taken eagerly by Pekin Robin, which, after much pecking and tasting, left the butterfly uneaten.

July 31, 1909. One male eaten at once by Brazilian Hangnest.

Sept. 20, 1910. One left untouched by Fantailed Flycatcher. Taken and tasted but left uneaten by Dial Bird. Taken by Yellow-crowned Hangnest, which held the butterfly in his foot against the perch, pecked off its wings and finally picked it to pieces, and ate at all events most of it.

Note.—The Hangnests which ate these butterflies are much less typically insectivorous in diet than the Flycatcher, the Pekin Robin, and the Dial Bird, which refused them.

The Large White (*Pieris brassicæ*).

Oct. 26, 1909. One taken from my hand and greedily eaten by Lion Marmoset.

May 26, 1909. One taken at once by Syrian Bulbul and eaten; also by Harmonious Shrike-Thrush.

Oct. 26, 1909. One taken from my hand and greedily eaten by cock Silver Pheasant and by Honduras Turkey.

One taken by Shama and finally eaten, but not with any approach to the readiness with which he had just previously eaten a Tortoise-shell and the *E. jurtina*. At one time I thought he was going to give it up; but finally he swallowed it.

One liberated in aviary was chased up and down by three Wood-Swallows which, however, owing to hesitancy at the moment

of coming to close quarters, did not catch it. It escaped into another compartment, and was promptly seized by the Harmonious Shrike-Thrush, which ate it after a deal of pulling about and tasting.

Aug. 21, 1910. Two males greedily eaten by cock Silver Pheasant.

One male caught by Pekin Robin and eaten after some time, the delay being caused not apparently by distastefulness, but by the difficulty of getting rid of the wings which were left uneaten. This bird held the insect to the perch with his foot when pecking.

One male eagerly taken by Pearl-spotted Owl, which held it up in one foot while pecking it. He pecked away for some time at the thorax and wings without making much headway. He then shifted it and pecked off the end of the abdomen. But as soon as he got the flavour of the exposed tissues he shook his head and repeated the shake with every taste, showing unmistakable signs of disliking the flavour. Finally he hopped to another perch, put the butterfly down, and after looking at it for a little time, flew away. I thought he had given it up; but upon returning to the cage ten minutes later the butterfly had disappeared.

One put into an aviary of Tanagers was chased by several birds which, however, hesitated at the critical moment to catch it, as if a little doubtful as to its nature. At last a male Scarlet Tanager took it in his beak, but not having the instinct to use his foot to hold it or to put it into a cranny, went on masticating it for at least five minutes without showing any signs of dislike. He apparently refrained from swallowing it on account of the wings. Ultimately he was robbed by a female of the same species, which, after getting rid of the wings, continued pecking and tasting and shaking her head in the intervals, quite obviously not enjoying the flavour. She managed the insect better than the male, jamming it first into a split orange, and then between the leaves of a palm to peck it the better. Ultimately she ate what was left of the body.

One male offered to a hen King Bird of Paradise. She looked at it and as soon as she saw the legs move took it, but dropped it at once to the bottom of the cage. After careful and long inspection, she pecked it once or twice, but showed no eagerness to eat it. I then gave the same insect to a Larger Hill Mynah, which soon swallowed it, wings and all.

One male taken and eaten at once by Ludwig's Bustard.

One male offered to Fantailed Flycatcher, but he would not touch it. Taken and tasted by Dial Bird, but left uneaten. Also taken and tasted by Black-winged Grackle, and left and subsequently refused twice. Quickly eaten up by Harmonious Shrike-Thrush.

Sept. 18 to 20, 1910. One caught on wing by Fantailed Flycatcher, which had just eaten a 'Blue.' He carried it to a window-sill, but after one or two pecks left it. Once or twice the

bird, after waiting a short while, tried it again, but finally left it alone.

It was then taken by a Dial Bird, which, after pecking it about for a short time, was robbed by the Sulphury Tyrant. The latter, after tasting it, left it alone. I then gave the remainder of the insect, consisting only of the thorax and wings, to a Yellow-crowned Hangnest, which took it to a perch, and holding it in one foot gradually pecked away the wings and dropped them, and then pecked the thorax to pieces, eating little bits of it and dropping others.

Pupa of the Large White (*Pieris brassicæ*).

Oct. 26, 1909. One offered to the Dial Bird which had fifteen minutes previously eaten the larva, but he would not touch it.

Offered to Yellow-crowned Hangnest which had tasted and dropped the larva. He looked at it but would not touch it.

Given to Harmonious Shrike-Thrush, which behaved just as the Dial Bird had behaved with the larva, pecking it and dropping it repeatedly to shake his head. He was then robbed of it by a Common Mocking Bird, which, however, dropped it in the grass from the perch, and made no attempt to recover it.

One offered to a Black-winged Grackle, a Javan Pied Mynah, a Fantailed Flycatcher, and a Sulphury Tyrant, all of which tasted it once, but not a second time. A Common Mocking Bird persevered a little longer, but finally dropped it and made no effort to pick it up again. Given to Harmonious Shrike-Thrush, was eaten without much hesitation.

Larva of the Large White (*Pieris brassicæ*).
Food not recorded.

Oct. 26, 1909. One taken by Yellow-crowned Hangnest, but soon dropped. Pounced upon by Dial Bird, which after many trials, pecking it and shaking his head after every taste, at last swallowed it; but he was evidently very uneasy for some twenty minutes afterwards, periodically shaking his head and opening his mouth and straining as if trying to vomit something nauseous.

Larvæ of the same fed on *Tropæolum* (so-called Nasturtium).

Sept. 13, 1910. Three eaten readily by Silver Pheasant and Reeves's Pheasant.

A small one given to Pekin Robin, which obviously did not like the flavour. He pecked it about in the sand for a long time, vigorously shaking his head after each taste. Ultimately, however, he ate it. I then gave him as a test the larva of a *Noctua* (see p. 835), which he also took and very soon swallowed entire without once shaking his head or evincing any sign of dislike. He then took a second and larger *brassicæ*-larva, treating it just as he did the first, but tackled it with still greater reluctance,

allowing himself to be robbed of half of it by another bird of the same species. The two finally finished it between them.

One given to a Shama, which after pecking and tasting it for a long time, with much headshaking, left it. It was then tasted by a Wood-Swallow, which left it after one peck. The Shama then tried it again, but left it. Then a Red-vented Bulbul took it, but soon dropped it. The Shama then tried it again and ended by eating it. This Shama was the same bird that ate the *Coccinella 7-punctata* (p. 846).

One given to Kagu, which after several attempts left it; and immediately afterwards greedily ate the larva of a *Noctua* (p. 835). This same Kagu ate *Timarcha tenebricosa*.

One taken by Green Hangnest, which at the time was greedily eating mealworms. The bird finally ate it, but evidently did not much like it, putting it down several times, and wiping it in the sand.

One given to Pearl-spotted Owl, which dropped it at once.

One given to Butcher Crow, which dropped it directly; but afterwards picked it up and swallowed it whole. Immediately afterwards, however, he vomited it up and left it on the bottom of the cage.

One smelt, but not touched by Common Marmoset, and by Capuchin.

One eagerly eaten by Meerkat.

Sept. 21, 1910. Larvæ of the same, fed on cabbage (*Brassicæ*).

Taken and eaten by:—

Elliot's Pheasant, Reeves's Pheasant, and Silver Pheasant. Vulturine Guinea Fowl. Crested Guinea Fowl. Ludwig's Bustard. Vigors's Bustard. S. American Thicknee. Cariama. Crested Curassow. Nigerian Ground Hornbill.

Also by Meerkats and Banded Mongoose.

Tasted but rejected by:—Shama, Red-vented Bulbul, Green Hangnest, Black Hornbill, Elate Hornbill, Trumpeter, Yarrell's Curassow, Globose Curassow, Crested Curassow, and Red-tailed Guan.

Notes.—The nature of the food of the larvæ did not appear to affect their taste. The Green Hangnest, it is true, refused larvæ fed on cabbage, having a week earlier eaten one fed on *Tropæolum*, but the bird was not eager for the latter, and I do not think this refusal of the former can be taken as strong evidence that he found them more unpalatable than the others. It is interesting that the Pheasants and Guinea Fowl, that is to say, Asiatic and African Gallinaceous birds, ate the larvæ eagerly, while the S. American Curassows and Guans, with the exception of one Crested Curassow, refused them after many trials, and much headshaking. One Curassow eagerly ate the larva of the *Noctua* (p. 835) after refusing that of *P. brassicæ*.

The Orange-tip (*Euchloë cardamines*).

July 31, 1909. One male given to *Cebus* (sp. *a*) was seized at once and stuffed into his mouth. He took it out, looked at it, smelt it, then ate it without hesitation.

This was a check experiment upon the behaviour of the monkey towards *Euchelia jacobææ* and *Melitæa artemis*. He showed much greater alacrity in eating the *cardamines* than either of the others. A *Pieris rapæ* given at the same time he ate without removing it from his mouth.

May 26, 1909. One male taken by the Harmonious Shrike-Thrush after a few moments' inspection and eaten entire, wings and all, with much less delay in the way of pecking and scraping on the soil than the same bird displayed when dealing with *M. artemis* and *A. euphrosyne*. Tested by this bird, *E. cardamines* appeared to be more palatable; but it is possible, though I do not think probable, that he ate it with less delay because he had just previously been robbed of the specimen of *Argynnis euphrosyne* by not swallowing it at once.

Group Nymphalinæ.

The Small Tortoise-shell (*Vanessa urticæ*).

Oct. 26, 1909. One taken and eaten by Shama which had just previously eaten *Epinephele jurtina*.

Hoopoe, Black-winged Grackle, and Harmonious Shrike-Thrush very eager to take one, but it was secured by the Grackle, which, however, was robbed by the Shrike-Thrush, the latter eating the butterfly in about half a minute without any signs of dislike such as shaking his head or wiping his beak.

Sept. 7, 1910. One taken and greedily swallowed, wings and all, by Dial Bird.

Sept. 18, 1910. One caught on wing by Fantailed Flycatcher, who carried it to a perch, but after a few tastes and pecks dropped it to the ground. Whether this was done intentionally or accidentally I cannot say, but the bird made no attempt to follow up the insect. I then gave it to a Dial Bird, which, after pecking it for a short time, was driven off by a Sulphury Tyrant. This bird, however, did not touch the butterfly. I then offered it to a Bulbul and a Yellow-crowned Hangnest; but neither touched it. I then offered it again to the Dial Bird, who finished it, but with no show of appetite. I am unable to say whether the indifference shown by the birds to this butterfly was due to its being distasteful or to the experiment being made at 5 P.M., when the birds had been feeding off and on through the day.

Pupa of *Vanessa urticæ*.

June 24, 1909. One placed on a branch near a Shama was taken after a good deal of preliminary inspection but was soon

flicked away and fell to the ground. The bird made no attempt to recover it. I then again put it on the branch by his side, and on this occasion he pecked at the little stem to which the pupa was attached. A hen Black Tanager was the next to try it. She broke the shell and getting the taste flew away with the pupa and, I think, ate it. At all events she flew up to the top of some brickwork where I could not see her clearly, and presently came down again without the pupa; and on going up a ladder to look for the pupa, I could find no trace of it.

One offered to Syrian Bulbul was taken after some scrutiny. The bird flew away with it and pecked it, but seemed greatly bothered and puzzled by the tightness with which it adhered to the twig. He was unable to detach it from the twig, and finally left it. I then offered it to a Fantailed Flycatcher; but could not induce this bird to touch it, although he scrutinised it carefully and was hovering round me the while, apparently remembering that on previous occasions I had given him butterflies. I then gave it to the Harmonious Shrike-Thrush, which took it, pecked away at it until he broke off the tail-end and ate it. He then pecked off another piece and ate it, showing no sign of dislike. He then left the larger piece; but soon returned, broke it up, and finally ate it piecemeal.

From watching the behaviour of these birds, I should say that these pupæ are unpalatable only to the extent afforded by the hardness and toughness of the chitinous integument. The birds that tasted them after breaking the exoskeleton, showed no signs of disliking the flavour. Those that took them—and the Flycatcher could not be induced even to attempt it—did so after scrutinising them in a way that suggested doubt as to their belonging to the category of eatable things. They did not appear to me to know what they were; and none of the many insectivorous birds in the aviary showed the least sign of eagerness when I first put the pupa on a perch, waiting to see which would be the first to come down. It was only when I placed it about a couple of inches from the Shama, a tame and fearless bird, that he took it. The Tanager came, and after her the Bulbul, when they had seen the Shama's attempt, or at all events after the Shama had first tackled it. These birds are accustomed to visitors and keepers bringing food into the aviary; and I think it probable that the Shama was induced to peck at the pupa merely because it was definitely offered to him.

I suspect that this pupa is protected in the first place by its likeness to things inanimate, and in the second place by the toughness of its integument which does not readily yield to a peck, and is quite in keeping with the general impression of lifelessness suggested by the colour, shape, and immobility of the whole pupa. I may add that I did not see the pupæ move when pecked by birds, although they did so when handled by myself.

Young larvæ of *Vanessa urticæ*.

June 24, 1909. One eaten without hesitation by Brazilian Hangnest, and by Common Mocking Bird; two by Shama; two by Orange-headed Ground-Thrush, and one by Harmonious Shrike-Thrush.

Two taken and tasted but whisked away by Larger Hill Mynah.

One taken and tasted but dropped by North American Cat-bird, which refused to touch a second.

One pecked and tasted many times, but finally rejected, by Fantailed Flycatcher.

The Peacock (*Vanessa io*).

May 26, 1909. One fluttered to ground and rested with wings closed. A Fantailed Flycatcher flew down to inspect and was preparing to peck, when the butterfly opened its wings and moved them slowly up and down. The transformation seemed to disconcert the bird, which made no attempt to peck, but danced round the insect at a distance of about three inches. A Shama and another Flycatcher, which joined the first, behaved in the same way. A Syrian Bulbul then flew down and drove the three away. After inspecting the butterfly for about half a minute, he pecked the ocellus of the anterior wing of the left side; the second peck struck the ocellus of the anterior wing of the right side; the third the ocellus of the posterior wing of the left side, tearing a piece out. He was then driven away by a Sun-Bittern, which looked at the butterfly for some two minutes, but made no attempt to peck it, although it excited his interest. I then removed the Bittern; and the Bulbul returned at once, seized the butterfly by the head and thorax, flew away with it, and devoured it.

One fell to floor of aviary with wings closed, and was at once seized by Syrian Bulbul, before its wings opened, and was carried away and eaten. A second Bulbul of this species pursued the first; but I do not know which of these two birds was the one that ate the *io* first introduced.

The two features of interest in the first experiment with this species were, first, the manifest disconcertedness of the three birds by the sudden display of colour and the slowly waving wings of *io* (my wife, who was with me, said at once, "They are afraid of its eyes"); and secondly, the consecutive pecking of three of the ocelli by the Bulbul. It can hardly have been by accident that the ocelli were accurately struck three times running.

Aug. 21, 1910. A specimen let loose in aviary was chased by a number of Tanagers and other small birds and was caught by a Scarlet Tanager. The latter, however, was robbed by a Pekin Robin, which ate the insect without showing any signs of dislike, the delay of five minutes in finishing it off being caused by the difficulty of managing the wings which the bird ultimately broke off and left uneaten.

The Red Admiral (*Pyrameis atalanta*).

Aug. 21, 1910. One taken and eaten greedily by Lion Marmoset.

One pursued by Shama, which grabbed it by the hind wing and thereby lost the butterfly, which flew away and escaped through the wires of the aviary.

The Painted Lady (*Pyrameis cardui*).

Aug. 27, 1910. One given to Pearl-spotted Owl was taken at once and swallowed entire after a little preliminary pecking.

This was a test experiment to ascertain the meaning of the bird's behaviour towards *Pieris brassicæ* (see p. 817).

Araschnia levana. Late summer form *prorsa*.

July 8, 1911. One given to Harmonious Shrike-Thrush, an Australian bird, was taken at once, but after being pecked and tasted for some little time, was rejected. The remains were then greedily eaten by a Wood-Thrush, from North America. A fresh specimen given to this same Wood-Thrush was just as readily swallowed; but the Shrike-Thrush upon taking another, treated it as before, wiped it in the sand, shook his head, and allowed himself to be robbed by a Black-chinned Laughing Thrush, which ate it and another without hesitation.

One taken and eaten, but very slowly and with much pecking about, by a Hoopoe, which, after swallowing the last particle, appeared to try to vomit it back but without success.

A Blue Rock-Thrush and a Common Rock-Thrush, both European birds, each ate one greedily.

One pecked and tasted for some little time by Orange-headed Ground-Thrush, which obviously did not care for the flavour, and allowed himself to be robbed by the Blue Rock-Thrush mentioned above.

One liberated in aviary dodged the pursuit of a Shama and a Sibia with great skill, and escaped.

One given to Shama was pecked and tasted for some time, but the bird allowed himself to be robbed by a Wood-Swallow, which, after much pecking, swallowed the butterfly.

This performance was repeated exactly when one was given to the Sibia, the same Wood-Swallow taking it from him; but I think the Sibia would have eaten it ultimately.

One given to Grey-headed Friar Bird, from Australia, was taken and tasted for a long time and then dropped, given again to the same bird, was again tasted and dropped. The remains were then eaten without much delay by a Larger Hill Mynah.

One given to a Dial Bird was taken and after much tasting was resolutely rejected. The remains were then given to a

Sun-Bittern, which persevered for some time but finally rejected them.

The only birds which ate the butterflies quite readily were the two species of Rock-Thrushes, the Wood-Thrush, and the Black-chinned Laughing Thrush. To the others they were obviously more or less distasteful, the most significant rejection being by the Shrike-Thrush, which on previous occasions has eaten almost every insect offered to him.

N.B.—These experiments were made between 4 and 5 P.M., when the birds had been feeding throughout the day.

July 9, 1911. One eaten readily by Black-headed Lemur, one by Meerkat, two by Common Indian Mongoose.

Three eaten readily by two Wall Lizards.

Two eaten readily by Silver Pheasant, and one fairly readily by Mantchurian Crossoptilon (Pheasant).

One given to White-eared Scops Owl was taken at once but dropped as soon as tasted.

Experiment repeated with same result.

Experiment repeated with same result with another specimen of the same species of Owl.

One given to Pekin Robin was taken at once, but put down upon the ground. For fully five minutes the bird continued to peck it and shake his head. He would neither eat it himself nor allow the other birds to take it from him. Ultimately he pecked it to pieces; but I cannot say whether he ate particles or wasted them on the ground. One thing was quite clear. He did not find the flavour to his liking.

Dark Green Fritillary (*Argynnis aglaia*).

July 21, 1909. One let loose in aviary was chased by Black-headed Sibia and Fantailed Flycatcher, but eluded both and escaped into a crevice. This is the first butterfly I have seen dodge the Flycatcher, which is extraordinarily adept at taking insects on the wing. I then gave it to the Spectacled Thrush, and he ate it after he had succeeded in shaking off its wings. The bird was keen not to lose it, and drove away the Flycatcher whenever he ventured near.

Silver-washed Fritillary (*Argynnis* (*Dryas*) *paphia*).

July 26, 1909. One caught on wing and eaten with avidity by Fantailed Flycatcher.

Also used as check upon *Melanargia galathea* which the Flycatcher had rejected (see p. 827).

July 31, 1909. One eaten readily by Brazilian Hangnest.

Pearl-bordered Fritillary (*Argynnis* (*Brenthis*) *euphrosyne*).

May 26 to 31, 1909. One eaten by Silver Pheasant. For details see under *Melitæa artemis* (see p. 826).

Two specimens given respectively to Brazilian Hangnest, and to Saturnine Mocking Bird, were eaten much more readily than were specimens of *M. artemis* offered to the same birds (see under *Melitæa artemis*).

One female taken by Harmonious Shrike-Thrush, but not eaten readily. While this bird was pecking the butterfly and wiping it on the gravel, he was robbed of it by a Red-vented Bulbul; the latter was in turn robbed of half of it by a North American Mocking Bird. The two finished it between them.

Small pearl-bordered Fritillary (*Argynnis* (*Brenthis*) *selene*).

May 31, 1909. One taken and eaten by Capuchin, but without relish.

One taken and eaten by Capuchin (*Cebus* sp. *c*), with obvious avidity.

Greasy Fritillary (*Melitæa aurinia* or *artemis*).

May 26 to 31, 1909. One male given to same specimen of *Cebus* that took the *Euchelia jacobææ* five minutes previously. He behaved in exactly the same way towards it. Stuffed it into his mouth, but the moment he got the flavour or the feel, took it out in his hands, pulled it to pieces, cautiously tasted it, and then ate it, but with no great show of satisfaction.

One taken and eaten by Capuchin (*Cebus* sp. *b*), but with great hesitation and no particular signs of relish. This monkey also ate one *Cœnonympha pamphilus*, one *Argynnis selene*, and one *Thanaos tages*; but treated them all in the same way, evidently not caring much for any of them. In this particular he showed a marked contrast to the two other examples of *Cebus*, sp. *a* and *c*, used for these experiments.

One male offered to Meerkat, taken and eaten at once. Eager for more.

One male offered to Capuchin, taken and eaten at once. Eager for more.

One male offered to White-handed Lemur, which after carefully smelling it, refused it.

Same one offered to Crowned Lemur and White-fronted Lemur, was smelt and refused in the same way.

Offered to Black Lemur, was smelt, then carefully taken into the mouth, but was then pulled out with the hand; then again tasted, but rejected as if distasteful, the tongue being rapidly protruded and drawn back through the front teeth as if to scrape off something unpleasant, perhaps scales.

One offered to Diana Monkey, was taken and eaten piecemeal, apparently with relish.

The mammals above mentioned had not been fed, and were without exception hungry.

One taken by Brazilian Hangnest, which pecked at it, ate a few pieces as if testing its flavour, then let it fall from the perch to the ground, and left it there.

One taken by Saturnine Mocking Bird, which shook it about, pecked it, ate a fragment or two, then left it.

One taken by Brazilian Hangnest, which pecked it several times, and finally ate it. The Mocking Bird then returned, and after many trials finished off the remains of the first specimen that had been left by the Hangnest and of the second that had been left by himself. It was quite evident that neither of these birds found much satisfaction in eating these butterflies.

One female liberated in aviary, caught on wing by Garrulous Honey-eater, and eaten without delay.

One female taken by Blue Rock-Thrush, but left on the ground after being pecked. Suspecting that his leaving it was due to my propinquity, I moved away and told the keeper to throw it to him, He then caught it on the wing, and ate it. He then came close to me on a perch and eagerly took another specimen (male) from my hand, then a third (female), and ate both greedily.

Two given to Silver Pheasant were taken and eaten, but with a great deal of pecking and tasting. Comparing this bird's behaviour towards them with his manner of eating *Pieris napi* and *rapæ*, I am quite sure he found them to a certain extent unpalatable. I thought at first that he merely disliked the wings. To test this I gave him immediately afterwards a specimen of *napi*. He took it from my hand and put it on the ground; then tasted it, and without more ado swallowed it. I then gave him a specimen of *rapæ*. He took it from me, and without putting it on the ground ate it up. I then gave him a specimen of *Perarge megæra*, which flew into a bush. He went after it, found it, caught it with the dexterity of a 'practised hand,' but treated it exactly as he treated the *artemis*, pecking and whisking it about, ultimately after much delay eating it piecemeal, but with what might be described as a very dubious air. He behaved in a precisely similar manner towards an example of *Argynnis euphrosyne*.

I am convinced that no one who had seen this Pheasant eat these five butterflies, could have doubted for a single moment that he found the 'Whites' pleasant to taste, and the 'Fritillaries' not altogether to his liking.

One male offered to Larger Hill Mynah was taken and eaten, but with no great relish, being frequently dropped and picked up again, and scraped in the sand.

One male offered to Levaillant's Barbet, which took it and behaved towards it in exactly the same way as the Mynah. The birds appeared to dislike the wings, and to want to get rid of them.

One male offered to Fantailed Flycatcher, which after a little inspection pecked it and took it, but was robbed by a Syrian Bulbul, which ate it.

Two males taken and eaten by Shama.

One male taken and eaten by Cape Robin-Chat.

One male taken and eaten by Indian Orange-headed Ground-Thrush, after being pecked and rejected by Hoopoe.

One male taken and eaten by Harmonious Shrike-Thrush.

One female taken and eaten after a great deal of pecking and delay by Indian Black-headed Sibia, which was chased for it by a Syrian Bulbul.

One female taken and eaten, after a few moments' inspection and biting at the wings before the position of the body was found, by a Sand Lizard. A Dugès's Lizard came up while the butterfly was being chewed, and after tasting it once or twice, attacked the Sand Lizard to make him relinquish his hold.

One male taken by the same Sand Lizard after he had finished the first specimen. I then made him drop it; and offered it to a Wall Lizard, which took it without delay and swallowed it.

Group Satyrinæ.

The Marbled White (*Melanargia galathea*).

July 24, 1909. As a check I first of all offered a specimen of *P. napi* to the cock Silver Pheasant. He took it from my fingers, and without hesitation swallowed it and turned eagerly for more. I then gave him a *galathea*, which he just as eagerly took, but promptly lowered his head to the ground and spat it out. He persevered with it, however, and after a little pecking and shaking, ate it. I then tried him with another *napi*. He took it and swallowed it at once, not hesitating for a single moment, exactly as he had done with the first one. Then I gave him another *galathea*, which he took but immediately put out of his beak upon the ground; but after some pecking and tasting he swallowed it.

I consider this bird to have rather a refined taste for insects; and I can now tell tolerably accurately by his behaviour whether he likes one or not. And I am quite sure that he found *napi* very palatable and *galathea* not so.

I then let a *galathea* loose in the aviary, and it was promptly caught on the wing by a Fantailed Flycatcher, which flew with it to the ground, and after pecking, pulling and shaking it about for a minute or so, gave it up and took no further notice of it. As a check I then tried him with *Aphantopus hyperanthus*, which he caught in the same way, and very quickly demolished. I then gave him another *galathea*, which he caught and pecked and shook for some little time; but he would not eat it. As a further check I gave him *Argynnis paphia*, which he caught and disposed of as quickly as he had disposed of the *hyperanthus*.

I noticed that some of these *galathea* had darker spots below than the others. Thinking that perhaps this might be a sexual difference, I gave one of each kind to the Pheasant and to the Flycatcher; but the birds behaved in exactly the same way towards them.

One caught and eaten by Dial Bird; also by Orange-headed

Ground-Thrush, and by White-cheeked Bulbul. The latter was robbed by the Harmonious Shrike-Thrush; but recovered the butterfly and ate it.

One given to Sulphury Tyrant, who pecked it and shook it for a long time, then allowed the Shama to take it from him. The Shama ate it. This was a *galathea* with lighter spots below.

One given to the same Shama was also eaten. This was a darker spotted specimen.

The specimen above alluded to that was rejected by the Flycatcher, was eaten by a North American Cat-bird (Thrush).

One offered to Australian Bustard, was taken from my hand and swallowed at once.

One given to Meerkat, was taken and eaten without hesitation.

One given to Capuchin, which by his rejection of the Telephorid beetle (p. 840) had shown himself to be more particular in taste than some others of his species, was eaten, but by no means greedily.

With the exception of the Australian Bustard none of the birds that ate the *galathea* did so with great alacrity. Swallowing them was in all cases preceded by a varying amount of flicking and shaking and pecking. When I began my experiments I thought this behaviour was due to a wish to get rid of the wings; but I am now doubtful about this, and believe that in many cases at all events it indicates dislike of the taste. When a butterfly is really to the liking of a bird, he disposes of the insect as fast as he can, without paying much attention to the wings. This struck me to-day particularly in the case of the Silver Pheasant when eating the *napi*, and of the Flycatcher when eating the *hyperanthus* and the *paphia*. The *paphia* especially was a large-winged butterfly for so small a bird; and yet he swallowed it, wings and all, in a few seconds.

The Meadow Brown (*Epinephele jurtina* × *janira*).

July 21, 1909. One female eaten at once by Lion Marmoset, which had previously refused to taste the malacoderm beetle (*Rhagonyche*) and the Saw-fly (*Allantus arenatus*).

One female taken from my hand by Spectacled Thrush, but made his escape. Caught on wing by Fantailed Flycatcher and eaten at once.

One female eaten at once by Common Pheasant.

July 31, 1909. One male caught on wing by Black-headed Sibia and eaten at once; another (female) caught on wing and eaten without delay by Fantailed Flycatcher.

Aug. 21, 1910. One male greedily eaten by Silver Pheasant. This bird at the same time ate with equal avidity a male specimen of *Pieris napi*. Her behaviour indicated no difference of taste between the two butterflies.

Oct. 26, 1909. One female taken and eaten fairly readily by Shama.

The Large Heath or Gatekeeper (*Epinephele tithonus*).

July 31, 1909. One eaten at once by Brazilian Hangnest.

Aug. 25, 1910. One caught and quickly swallowed entire by Pekin Robin.

One male taken and swallowed entire with scarcely any delay by Pearl-spotted Owl.

Sept. 20, 1910. One caught on wing and eaten without delay by Fantailed Flycatcher. This bird would not touch two White Butterflies (*P. brassicæ* and *napi*), offered one just before and one just after it took *tithonus*.

The Ringlet (*Aphantopus hyperanthus*).

July 26, 1909. One caught on wing and eaten with all speed by Fantailed Flycatcher.

I used this specimen as a check upon *galathea*, which the bird had just refused to eat after catching it and pecking it about for some time.

One gobbled up at once by Silver Pheasant.

The Small Heath (*Cœnonympha pamphilus*).

May 26, 1909. Two taken and eaten at once by Fantailed Flycatcher.

One taken by Fantailed Flycatcher which was at once chased by Syrian Bulbul.

One seized by Orange-headed Thrush, which after carrying it about gave it through the bars of the partition to another bird of the same species. This was deprived of it by a Bower Bird, which carried it about, perhaps as a possible ornament, since he made no attempt to eat it.

The Wall Butterfly (*Pararge megæra*).

May 31, 1909. One taken and eaten by Capuchin (*Cebus* sp. *b*), but without apparent liking (see under *Melitæa artemis*).

One taken and eaten with avidity by Capuchin (*Cebus* sp. *c*).

Aug. 25, 1910. Eagerly taken and eaten by Red-handed Marmoset.

May 31, 1909. One eaten by Silver Pheasant (see also under *Melitæa artemis*).

Aug. 25, 1910. Two (male and female) caught and greedily eaten, wings and all, by Pekin Robin.

Sept. 5 to 7, 1910. One female taken at once by Ludwig's Bustard, which, however, let it escape. It was caught on the wing and quickly eaten by a Larger Hill Mynah. Two more specimens (female) eaten by Black-winged Grackle and by Dial Bird.

The Grayling (*Satyrus semele*).

July 31, 1909. One caught on wing by Fantailed Flycatcher and eaten with all speed.

Group Lycænidæ.

Common Blue (*Lycæna icarus*).

Oct. 26, 1909. One given to Shama, but it avoided him and flew through into the next compartment, where it was captured smartly by a White-browed Wood-Swallow, and eaten as soon as the bird could get peace from the pursuit of two other Wood-Swallows in the same compartment.

N.B.—These Wood-Swallows were desperately keen to get the butterflies with which they saw me feeding the Shama in the next compartment.

One male let loose in aviary containing Fantailed Flycatcher, which I should describe as an expert butterfly-catcher. But the Blue dodged him again and again, and got through into the next compartment. Here again it avoided the swoop of one or two birds whose identity I did not detect in my intentness in keeping my eye on the butterfly. The latter then passed through to a third compartment and settled on some yellow painted boarding, which it did not match, and on which it was caught by a Brazilian Hangnest, and quickly eaten.

One male caught deftly by Masked Wood-Swallow, which after prolonged pecking and tasting, swallowed the body, having got rid of the wings. This bird used its foot to hold the insect down.

One male caught by Pekin Robin and ultimately swallowed entire; but the bird put the insect down many times before swallowing it.

The behaviour of these two birds suggested that this 'Blue' was not very palatable. Its size offered no obstacle to its being swallowed at once; but both birds delayed over the meal.

Two (male and female) given in succession to Pearl-spotted Owl were taken and swallowed entire without delay.

Two (male and female) let loose in aviary were captured and quickly swallowed entire by Pekin Robin.

The Brown Argus (*Lycæna astrarche*).

Sept. 18, 1910. One let loose in aviary was taken by a Cayenne Tanager, which was quickly robbed by a Pekin Robin. The latter ultimately swallowed it entire, after putting it down several times before finishing it off.

One caught on wing and eaten at once by Fantailed Flycatcher.

One caught and eaten at once by Dial Bird.

The Small Copper (*Chrysophanus phlæas*).

Aug. 25, 1910. One caught and swallowed quickly, wings and all, by Pekin Robin.

Group Nemeobiinæ.

The Duke of Burgundy (*Nemeobius lucina*).

June 15, 1909. One given to Brazilian Hangnest was taken and swallowed without any hesitation.

One given to Saturnine Mocking Bird was taken at once, but not eaten eagerly. While she was pecking it about a Lesser Hill Mynah flew up and took it away, but was in turn deprived of it by the Mocking Bird, which then swallowed it quickly.

Two given to Silver Pheasant, which ate them with the same eagerness as it had previously shown when tried with the 'Whites.'

Group Hesperiidæ.

The Dingy Skipper (*Thanaos tages*).

May 31, 1909. One taken and greedily eaten by Dent's Monkey.

One taken and eaten cautiously by Capuchin (*Cebus* sp. *b*). See under *M. artemis*.

The Large Skipper (*Argiades sylvanus*).

July 21 to 31, 1909. One caught and eaten at once by Fantailed Flycatcher, and one by Brazilian Hangnest.

Moths.

Larva of Goat-Moth (*Cossus ligniperda*).

Sept. 20, 1909. One taken first of all by Dial Bird, which after a short time was driven off by Sulphury Tyrant. Both, after pecking it, left it practically uninjured on the ground. It was then taken by the Harmonious Shrike-Thrush. He kept it for some time, pecking it about and was eager to prevent other birds getting it; but was finally beaten in a 'tug-of-war' for it by a Common Hangnest, which carried the grub to a bush, held it against a branch with his foot, and pecked away for five minutes, then voluntarily dropped it. It was then taken by a Dial Bird, which persevered for a long time, pausing frequently between the pecks, opening and shutting and wiping his beak. He was then deprived of it by a Black-chinned Laughing Thrush, which kept it for ten minutes, pecking and whisking it about without making any visible impression on the skin. The head, however, was by this time gone, and the bird pulled some soft tissues out of the end and ate them. I then gave it to a Green Hangnest, but after tasting it he let it drop and took no further notice of it. I then gave it to a Leach's Laughing Kingfisher, which after a little delay swallowed it whole.

Larva of the Lackey (*Clisiocampa neustria*).

Sept. 20, 1909. Seized at once by a Shama which flew away with it, holding it by the head; but while he was adjusting it for eating, the female Black Tanager grabbed the other end and being victorious in the tug that ensued, carried away the larva and, after a good deal of pecking, ate it.

Six-spotted Burnet (*Anthrocera* (*Zygæna*) *filipendulæ*).

July 31, 1909. One placed on a branch was immediately seized, but flicked away by a Black-headed Sibia, which made no attempt to follow it up but flew away, shook his head once or twice, and wiped his beak.

Sulphury Tyrant then pecked it and flicked it away; and tried it again with the same result, and left it.

Harmonious Shrike-Thrush took it eagerly, wiped it on the ground several times, then jammed it into a forked branch and started gingerly pulling it to pieces with much shaking of his head and wiping of his beak. He then broke it in two pieces; flew away with one and pushed it into a cranny and still persevered. He then broke another piece off, and stuck it in a cleft branch; but finally left it. I did not see him eat any of the moth although he may have swallowed small particles. In any case there were pieces of it left in the places where he had fixed them.

The Cinnabar Moth (*Euchelia jacobææ*).

July 31, 1909. One given to Meerkat, which caught it on the wing with a snap, devoured it with every sign of relish, and seemed eager for more.

One given to Capuchin (*Cebus* sp. *a*), which stuffed it into his mouth at once, chewed it, then hastily took it out again, apparently finding he had something either unusual or unpleasant on his tongue; smelt it, pulled it to pieces with his hands, and finally ate it, but with a good deal of doubt as if undecided as to whether it was nice or nasty.

July 5, 1909. One specimen offered to a Fantailed Flycatcher was immediately seized and pecked and tasted, and then rejected. The Shama then tried it, and treated it in the same way, finally rejecting it. A second Flycatcher then tasted it, and rejected it.

Another specimen of the moth let loose in this aviary flew through the wires into another compartment, and was captured on the wing by a Pied Grallina. He pecked it once or twice, and tasted it, then flew away. A Cuban Mocking Thrush then came up, and while he was looking at it and hesitating to peck, the Grallina came back, drove away the Mocking Bird, seized the moth and gradually ate it, holding it in one foot and pecking it to pieces.

Larva of Cinnabar Moth.

Aug. 15, 1909. Inspected but not touched by English Thrush.

Offered to many fowls, only one of which pecked it, but dropped it at once and took no further notice.

Magpie Moth (*Abraxas grossulariata*).

Aug. 1909. Offered to fowls, was inspected by several, but only pecked by one, which at once dropped it, and made no further attempt.

Small Green Geometra larva, probably of *Cabera pusaria* or *exanthemaria*.

May 26, 1909. One taken without any hesitation by a Shama; but dropped. Then taken a second time, and dropped. When preparing to take it a third time, he was deprived of it by a Black-headed Sibia, which after spending a few seconds adjusting it in his beak, swallowed it. It appeared to me that the Shama dropped this larva accidentally, owing to lack of skill in adjusting it in his beak, rather than intentionally. He was just as eager to take it, although dead, the third time, as the first.

The Swallow Prominent (*Pheasia dictæa* or *tremulæ*).

July 12, 1909. Flattened itself to the ground but was at once pounced upon by the same Flycatcher that had just eaten the Hemerobiid (see p. 835). The bird, without any hesitation, ate it with all speed, being merely delayed by the trouble of adjusting the wings. Both this moth and *Mamestra persicariæ* betrayed their identity as Lepidoptera by flying out of the boxes to the ground, so I had no chance of judging whether the Flycatcher or other birds would have been deceived by their procryptic coloration.

The Buff-tip (*Phalera bucephala*) (imago).

July 5, 1909. Not being aware of this moth's propensity, I picked it up by the wings, whereupon it immediately twisted its abdomen round and ejected a stream of white fluid over my fingers. I regret that I missed seeing this defensive device practised on a bird. However, I placed the moth on a wooden branch, and a Fantailed Flycatcher flew down to inspect it; after loooking at it for a few seconds, he flew away. I then put it near a Shama, who hopped up to it and almost immediately picked it up by the thorax. The other birds in the aviary now became interested and pursued the Shama, giving him no chance of eating it. When on the wing he dropped the moth, and the Fantailed Flycatcher, which had previously taken no notice of it,

immediately pounced on it, and after one or two efforts swallowed it at a gulp.

My impression is that the Flycatcher did not suspect the moth of being eatable until he saw the Shama take it. It certainly looked very like an inanimate excrescence as it rested on the perch. Presumably the moth had exhausted its intestinal artillery upon me, because it shot out no more when seized by the birds, but kept perfectly quiet without even flapping its wings, although the Shama did not crush it, and having it end on by the thorax with the moth's head in his mouth, left the wings perfectly free to flap, and the abdomen to wriggle, had the moth been disposed to struggle. This behaviour, I take it, was a manifestation of the deeply implanted instinct to keep absolutely still (commonly called 'death-feigning'), which is so highly developed in many animals with procryptic shape and colour.

The Dot (*Mamestra persicariæ*).

July 12, 1909. One flattened itself to the ground, and was seized by the Fantailed Flycatcher that had eaten *Pheasia tremulæ*, and was eaten with avidity, delay, however, being caused by the bird's desire to get rid of the wings as well as by being disturbed by another Flycatcher and a Syrian Bulbul, which tried to deprive him of the moth. The Bulbul subsequently picked up the pieces of wing and ate them.

Larvæ of the Bright-line Brown-eye (*Mamestra oleracea*).

Oct. 26, 1909. One given to Harmonious Shrike-Thrush was taken after a moment's scrutiny. He pecked it, and tasted it three or four times, then swallowed it readily enough. His behaviour suggested to me a certain amount of caution at first, as if he remembered the distastefulness of the pupa of *Pieris brassicæ* which he had just previously eaten. The green hue of both gave them a superficial similarity to one another. Having eaten the one specimen of *oleracea* he was very keen to get the second.

This I gave to the Black-winged Grackle which a few minutes previously had unhesitatingly left the pupa of *P. brassicæ* after one taste. He took it, and after a taste or two proceeded to eat it with avidity, not giving the Shrike-Thrush, who was hovering near and following him up for an opportunity to snatch it, a chance to do so.

Larva of Drinker (*Cosmotricha potatoria*).

May 26, 1909. One thrown to floor of aviary, was followed by many birds and secured by a female Black Tanager, which carried it to a perch and proceeded to peck it and shake it for about one minute. She then dropped it, and it was seized by the Black-headed Sibia, but was dropped at once. The Tanager thereupon tried it again; and again let it fall, this time almost

immediately. Two Fantailed Flycatchers then came up and inspected it. One of them pecked it, but let it alone after one experimental taste. The larva was by this time dead. Then a Sulphury Tyrant came up, picked it up and after a peck or two swallowed it.

Larva of *Noctua* (unidentified).

May 26, 1909. Two (fed on *Tropæolum*, so-called Nasturtium) eagerly eaten by Pekin Robin and by Kagu.

One (fed on cabbage) was readily eaten by Yarrell's Curassow, which had just rejected the larva of the Large White (*Pieris brassicæ*) and of the Small White (*P. rapæ*).

Order **NEUROPTERA**.

Hemerobiid (unidentified).

July 12, 1909. One turned loose in aviary was at once caught on the wing by Fantailed Flycatcher and eaten without hesitation. The bird wiped its beak two or three times on a branch afterwards; but I do not think this action can be regarded as a certain sign that it wished to remove something unpleasant. It suggests the possibility, however, especially in view of the fact that the action was not repeated by the same bird after greedily eating *Pheasia dictæa* and *Mamestra persicariæ*.

Large Black and Yellow Dragon Fly
(*Cordulegaster annulatus*) male.

July 26, 1909. One pounced upon and eaten after a time by Harmonious Shrike-Thrush.

Order **ORTHOPTERA**.

Common Grasshopper (*Stenobothrus* sp.).

Sept. 6, 1910. One given to Pekin Robin was eagerly taken and eaten, but not with great rapidity, the bird putting it on the ground between the pecks, but without once shaking his head or showing any signs of disliking the taste. He appeared to me to be troubled by the insect's legs.

Great Green Grasshopper (*Locusta viridissima*).

All the birds in the aviary were keen to get it. It was tackled at once by a Dial Bird; but he was driven off by a Black Tanager, who flew away with the insect and pulled it to pieces on the top of a wall.

Sumatran Stick Insect (*Lonchodes* sp.).

Taken and eaten at once by:—Pinché Marmoset, Lion Marmoset, Douracouli, Capuchin, and Banded Mongoose.

Taken in the hand, but put down untasted and unhurt by Grey Lemur.

Taken and eaten at once by:—Silver Pheasant, Cartagenian Motmot, Fantailed Flycatcher, two Dial Birds, Shama, Black-chinned Laughing Thrush, two White-crested Jay-Thrushes, Black-winged Grackle, Chinese Mynah, Brazilian Hangnest, and Shrike.

The Shrike was too shy to take the specimen from my fingers, so I threw it towards him on the sand, not seeing exactly where it fell. He, however, saw the direction of the falling insect, and hopped towards it, but somewhat to my surprise—for birds seldom lose sight of thrown food—did not pick it up but looked as if inquiringly up at me. After a little search I found the small Stick Insect on the sand lying still with legs extended, and looking exactly like a blade of green grass. When I stirred it up and made it crawl, the Shrike was on to it in a moment; and I have no doubt that he missed it in the first instance owing to its resemblance to the grass blade.

I observed that several of the birds looked inquiringly, as I should describe it, at the Stick Insects before taking them. One in particular, the Harmonious Shrike-Thrush, usually one of the keenest insect-eaters in the Gardens, hesitated on two occasions so long before making up his mind to touch them that he was promptly robbed of his prey, once by a Dial Bird and once by the Black-chinned Laughing Thrush.

Two birds took them directly, but instead of eating them, hopped about with them in their beaks. One of these, the Green Hangnest, was deprived of his by a Chinese Mynah, which took it from him through the partition bars of the next aviary; the other, a Grey Struthidea, was similarly robbed by a White-crested Jay-Thrush after a Collared Jay-Thrush had made several attempts to get it from him.

Order **COLEOPTERA**.

Group Geodephaga.

The species of this group used for the test belonged to the Carabidæ, a family of carnivorous ground-beetles with an exceedingly hard exoskeleton. *Carabus violaceus* is black with blue reflections; the species of *Pterostichus* are dead black and shine like pitch. *Harpalus* has pubescent elytra and is a little less conspicuous.

Carabus violaceus.

July 31, 1909. One rejected, after being smelt by three Meerkats, two Banded Mongooses, and one White-tailed Mongoose. The latter behaved towards it exactly as he did towards the *Ocypus olens* (see p. 838).

Offered same specimen to Harmonious Shrike-Thrush, which seized it eagerly but was robbed by the Dial Bird. I am sure by the way they tackled the beetle that either of these birds would have eaten it; but the Spotted Bower Bird robbed the Dial Bird, as in the case of *O. olens*, and finally finished it.

July 31, 1909. One dropped on to floor of cage of the Meerkat which had just eaten a *Timarcha tenebricosa*. He pounced on it, but would not seize it as he did the *Timarcha*. I think he bit it, but am not sure. However, by the way he pawed it about I am convinced he did not care for it. While he was holding and smelling it, he quite suddenly let it go and vomited up the *Timarcha* (see p. 841). The *Carabus* escaped unhurt. I then gave it to a Capuchin which seized it, and was proceeding apparently to eat it when another snatched it from him and ate it without showing any marked signs of dislike, but with no great avidity.

This species, like others of the genus *Carabus*, discharges from its mouth when handled a most repulsive smelling fluid.

Mr. Beddard found that *Lacerta ocellata* ate this beetle.

Pterostichus (*Abrax*) *striola*.

July 26, 1909. One taken by Sulphury Tyrant which shook it and pecked it for some time until robbed of it by Spectacled Thrush. This bird also pecked it and banged it about until robbed by female Black Tanager, which ultimately ate it after much pecking and tasting.

The delay in eating this beetle on the part of the birds that tried it may have been due to its hard exoskeleton or to partial unpalatableness from other causes. The hardness alone would, I think, account for it.

One (dead) given to Silver Pheasant was swallowed entire with very little delay. The bird, however, after taking the insect from my fingers, put it on the ground as is his custom with anything hard or with soft butterflies not quite to his liking.

July 31, 1909. One seized and bolted at once by Silver Pheasant in exactly the same way that he had bolted the other Carabidæ.

Pterostichus niger.

July 31, 1909. One smelt but rejected by three Meerkats; snatched from the forceps by a Common Indian Mongoose, which followed it and watched it, and smelt it as a cat does a cockroach, but did not eat it, so I took it from the cage uninjured. White-tailed Mongoose turned from it in disgust.

One seized and bolted at once by Silver Pheasant.

According to Mr. Beddard this beetle was eaten without hesitation by *Lacerta vivipara* and another lizard: and with some hesitation by Finches.

Pterostichus (*Steropus*) *madidus*.

July 31, 1909. One smelt and refused by three Meerkats. Seized and eaten by White-tailed Mongoose. This Mongoose is a large animal approaching a cat in size.

One seized and bolted by Silver Pheasant.

One pecked twice by Elliot's Pheasant, but escaped into the grass unhurt.

One seized and eaten by Black-headed Sibia.

Harpalus ruficornis.

July 21, 1909. One pecked at twice by Silver Pheasant but not eaten, the bird taking no further interest in it after the second peck. The beetle escaped unhurt.

Group Brachyelytra.

Devil's Coach-horse or Cock-tail Beetle (*Ocypus olens*).

(Uniformly velvety black in colour.)

July 31, 1909. One smelt and rejected at once by three Meerkats, one Mongoose, one Banded Mongoose, and by the White-tailed Mongoose that had just before eaten the *Timarcha* (see p. 842). This Mongoose started away from the scent in a way that reminded me of the behaviour of a person who finds a bottle of smelling salts unexpectedly pungent.

Offered the same specimen to Harmonious Shrike-Thrush, which tackled it at once, but while pulling it to pieces was robbed by the Dial Bird, and this bird in turn was robbed by a Spotted Bower Bird, which ate it.

Note.—The difference between the Viverrine mammals and the birds in their behaviour towards the Ground Beetles (Carabidæ and *Ocypus olens*) was very marked, and is to be in a measure explained, I think, by the wide difference in their powers of smell. The beetles appear to be relished by the birds; but to be nauseous to the mammalia. This perhaps is natural; because the Passerine birds would seldom come across the Ground Beetles, which are cryptozoic and largely nocturnal. The mammals like the Meerkats, and the Mongooses, on the other hand, must commonly find them as they grub about and hunt for food on the ground. Therefore one would expect protective attributes, if existing at all in these beetles, to be of a kind to guard them against being eaten by Meerkats or insectivorous mammals of similar habits.

The Silver Pheasant which ate these beetles is essentially a diurnal feeder and would seldom find nocturnal beetles. After seeing him eat the *Pterostichi* as if they were large seeds, I do not understand why he did not eat the *Harpalus ruficornis* offered to him some time previously*.

* Mr. G. A. K. Marshall suggested at the meeting when this paper was read that the *Harpalus* had retained while the *Pterostichi* had discharged their acrid juices.

Group Lamellicornia.

Dung Beetle (*Geotrupes vernalis*).

July 23, 1909. Offered to Pearl-spotted Owl, which blinked at it, but refused to touch it. Offered to a White-eared Scops Owl, was at once taken and held up in one foot; but after a few pecks, which removed some legs, it was let fall, no effort being made to recapture it. Given to a Ludwig's Bustard, was eagerly taken, and swallowed whole after a few pecks.

The large Cockchafer (*Melolontha vulgaris*).

July 23, 1909. One dropped on floor of aviary was pounced upon by Indian Dial Bird which had just before been trying the *Timarcha*. He pecked it, hammered it with his bill, and after a great deal of difficulty broke it in half. He evidently liked it, because he would not give any other bird a chance of getting it. However, when he had broken it up, the Harmonious Shrike-Thrush secured one half and carried it away, and after pecking it for a few minutes swallowed it. The Dial Bird in the meantime finished off his portion.

Stag Beetle (*Lucanus cervus*) male.

July 31, 1909. This I showed to some Capuchins, which evinced the greatest eagerness to secure it, but no sign of fear. I gave it to one, and his first act was to bite off the mandibles. This may have been an accident, but it reminded me of the alleged action of baboons in removing the stings of scorpions before they can do any damage with them. He then bit off the legs, finding they worried him, and sitting down munched up the beetle as if it had been a bit of apple. On a previous occasion I gave a dead Stag Beetle (male) to some Brush Turkeys. One seized it and was promptly chased round and round the enclosure by the others, which evinced the greatest keenness for a share. I could not wait to see what ultimately happened to the insect.

Group Longicornia.

Strangalia armata, the only species of this group experimented with, is a black and yellow, somewhat wasp-like flower-haunting diurnal beetle, with a very hard exoskeleton.

July 21 to 31, 1909. One taken at once from my hand by Silver Pheasant and eaten after a good deal of pecking and breaking up. The way the bird persevered with this hard-shelled beetle shows that his rejection of the *Harpalus* was not due to its hardness (p. 838).

One offered to Fantailed Flycatcher, which, however, would not touch it. Black-headed Sibia took it without hesitation, and flying away with it pecked it to pieces and finally ate it. Further

evidence of the bird liking the insect was shown by the way he flew away with it when chased.

One taken and eaten by Dial Bird, which was apparently only delayed in disposing of it by the hardness of the exoskeleton.

One taken and similarly disposed of by Great Barbet.

One eaten after being broken up and crushed by Brazilian Hangnest.

Group Malacodermata.

The beetle of this group used for the experiment is a flying diurnal flower-haunting species, with a soft exoskeleton. It is quite fearless of exposure. Beetles allied to it commonly form centres of mimetic attraction in the tropics.

Telephorid (? *Rhagonyche fulva*).

July 21, 1909. Four offered to four Capuchins were eaten, two readily and without examination, two after a good deal of tasting and examination between the tastes.

Two offered to two Capuchins were taken into the mouth, tasted, then taken out, wiped on the bars and left.

One refused by Ceylonese Macaque after being smelt.

One eaten by Mona Monkey after a good deal of tasting, smelling and pulling about. This Mona also ate the bug *Tropicoris rufipes* (p. 847).

One offered to Lion Marmoset was taken in the hand, smelt, and promptly dropped. The Marmoset then descended from the perch, picked it up again, smelt it and dropped it. The beetle crawled away unhurt.

One smelt once or twice by Meerkat, was rejected without being tasted.

One taken by Silver Pheasant, was pecked twice and left alone. Another offered to same bird was pecked once and left. One taken by Fantailed Flycatcher was pecked and tasted, then left. The same specimen was then pecked once or twice by a Shama and rejected. Black-headed Sibia then tried it, but gave it up and vigorously wiped his beak after a taste or two. Afterwards he made another attempt with the like result. The Black Tanager then took it, tasted it, wiped his beak and rejected it.

One caught on wing by Harmonious Shrike-Thrush was eaten after much pecking and pulling about. Another was treated in the same way by this bird.

Two specimens, one of which was dead, offered to and eaten by Dial Bird.

One tasted two or three times by Shama but rejected.

One pecked by Black-chinned Laughing Thrush, but flicked away. Pounced on and eaten by Dial Bird.

Although eaten by the Dial Bird and the Shrike-Thrush, which ate most of the insects offered to them, and by some of the

Monkeys, there can be no doubt that this soft-shelled beetle possesses distasteful attributes. Its rejection by the Meerkat, which ate nearly all the insects offered to it with the exception of *Coccinella 7-punctata*, was very significant, and suggestive of nasty smelling secretions.

Group Phytophaga.

The three species of this group that were tested are well-known species. They are slow-moving diurnal forms found on plants of different kinds. They are squat in shape, dorsally convex, and have a very hard exoskeleton, the Ladybird (*Coccinella*) being in addition exceedingly slippery and difficult to hold. The coloration of the latter is orange with black spots. The others are uniformly black or blue. *Timarcha tenebricosa*, the familiar 'bloody-nose beetle,' is further notorious for the discharge from its mouth of a crimson liquid, whence the trivial name is derived.

Chrysomela polita.

July 31, 1909. One offered to Meerkat was smelt and refused. Another Meerkat in the same cage took it in his mouth, but spat it out; both then sniffed it as it lay on the ground, but would not touch it.

The same specimen, offered to a Grison, was sniffed but not touched. Snapped up by McCarthy's Mongoose; but was at once spat out and left. It was then taken and eaten by a Banded Mongoose.

Query: Had the previous tasters exhausted the Beetle's supply of nauseous juices?

One given to Dent's Monkey was taken, rubbed between the hands and in the sawdust, smelt, tasted, pulled about and rejected. Picked up by Mona in the same cage, but rejected after one taste. This Mona had just eaten a living *Bombus*.

One given to Harmonious Shrike-Thrush was taken, pecked and tasted for a little, then left. Picked up by Black-chinned Laughing Thrush, was pulled to pieces, and rejected. This bird may have eaten pieces of the beetle, but the other débris was left on the turf. He did not appear to find it very unpalatable. Possibly in this case the nauseous juices had been exhausted by the Shrike-Thrush.

One pecked off a perch by Fantailed Flycatcher, but not followed up. Pecked and tasted by Sulphury Tyrant, but left. Then tried by Sun-Bittern, but also left, crushed but with nothing missing.

Timarcha tenebricosa (=*lævigata*).

July 23–31, 1909. One offered to a Meerkat was eagerly seized, chewed up and swallowed without much hesitation. But while this Meerkat was just afterwards occupied with the *Carabus violaceus* (cf. *supra*, p. 837), he vomited the *Timarcha*. I do not know

whether the sickness was caused by the smell of the *Carabus*, which to me is nauseating, or to its taste, or by the irritation of the stomach caused by the *Timarcha*. I suspect the latter, because the Meerkat refused to touch a second *Timarcha* that was offered to him.

One smelt and rejected untasted by two more Meerkats; taken by a third in the same cage, rubbed in the sawdust, but left apparently uninjured.

One grabbed at once and eaten by White-tailed Mongoose, which immediately afterwards heaved and went through the action of vomiting without, however, ejecting the beetle. A second specimen was smelt and rejected with every show of disgust by the same animal, which persistently refused for the next two hours every beetle that was offered him, although before eating the *Timarcha* he had devoured a *Pterostichus madidus*. One rejected without being closely smelt by a Banded Mongoose which had eaten a *Coccinella 7-punctata*. Seized by a second Banded Mongoose, and eaten after a good deal of rubbing in the sawdust.

One offered to a Capuchin, one of the specimens which had refused the Telephorid (*Rhagonyche fulva*) (p. 840), was taken, smelt, and rejected.

One offered to another Capuchin was ultimately eaten piecemeal, but with so much delay caused by handling, licking, and inspection, that I am sure it was no great treat to him, especially as he had every reason to eat it speedily because a bigger Capuchin in the same cage, which had snatched the *Carabus* from his grasp, was almost continually after him to get the *Timarcha*. When monkeys like their food they gobble it up if there is the least likelihood of another taking it.

One offered to a Vervet Monkey was accepted, pulled to pieces and eaten, the exoskeleton being dropped to the ground.

This specimen of *Timarcha* had been previously offered to a Baboon (*Papio sphinx*); but he would not even touch it.

One put on the floor of aviary was pounced upon by Dial Bird, which after continued pecking and hammering could make nothing of it beyond breaking it in half at the waist. Ultimately he left it. An Orange-headed Thrush then tried the abdomen, but was driven off by a Hoopoe, which after pecking and hammering it, gave it up. The Thrush then tried again, and also gave it up. A Black-chinned Laughing Thrush then had a turn; but with the same result.

One given to Harmonious Shrike-Thrush which had eaten the *Coccinella*. He persevered for a long time, but could not manage it and flew away, leaving the beetle apparently unhurt. After about five minutes the bird came back and tried again, this time pecking off the legs and antennæ of the beetle; but he would not eat the body, and at last flew away and returned no more.

Sept. 18, 1910. One female taken by Kagu, well crushed, then swallowed at a gulp.

One male taken by Vigors's Bustard, crushed and put down with a head-shake; then tasted by two Ludwig's Bustards, the three birds having alternate pecks at it, the Vigors's Bustard finally swallowing it.

One female well tasted, but rejected by Wood-Swallow, Black-winged Grackle, Javan Pied Mynah, and Black-chinned Laughing Thrush: also by Sun-Bittern, which persevered for a long time, repeatedly washing the beetle in the water-trough, and taking a drink at the finish.

Taken and pecked to pieces, and eaten bit by bit by Silver Pheasant. The bird wiped his beak several times on the earth, and for some little time afterwards stood opening and shutting his beak like a monkey or a human being getting the flavour of something tasty.

Some of the birds which tried to eat the *Timarcha* showed no special signs of finding them unpalatable. It appeared to me that they finally refused them on account of the hardness of the exoskeleton. Probably this prevented them getting at the softer tissues containing the flavour, whether unpleasant or otherwise.

Larva of *Timarcha tenebricosa*.
(A fat bluish-black grub.)

June 15 to 24, 1909. One eaten with apparent relish by Meerkat, which only delayed seizing it for about two seconds to rub it in the sawdust and smell it. This was the same Meerkat that on a previous occasion had eaten *Euchelia jacobææ* and rejected the *Coccinella*.

One taken at once by the same Capuchin that had eaten *E. jacobææ* and rejected *Coccinella*; but after crushing it between his teeth and getting the flavour, the monkey at once took it out in his hands, contemplated it for a few seconds, and moving his lips the while as if sampling the flavour, then letting it fall, retired to the back of his cage, salivated and heaved twice as if going to vomit.

Another Capuchin in the same cage now picked up the crushed larva, tasted it, and put it down; and neither of the monkeys touched it again. So I gave it to the Meerkat, which ate it as greedily as it did the first.

One given to Armadillo was eaten after a good deal of smelling. A second was eaten without hesitation.

One given to Dent's Monkey was eagerly taken and tasted, but almost at once dropped. The monkey did not taste it again, although he was interested in it and played with it for some little time.

One given to Mona Monkey, which behaved in much the same way as Dent's Monkey, but played with the larva for a longer time.

One given to Capuchin (sp. *a*) was taken and chewed up, but

just as I thought he was going to swallow it, he spat it out with profuse salivation.

One given to another Capuchin (sp. *a*) was licked and dropped.

One given to a third Capuchin (sp. *b*) was chewed up and swallowed without any signs of dislike, the larva being not even taken from his mouth for examination.

Another given to the same monkey was also eaten without any signs of dislike, although he held it in his hands and licked it several times before finally putting it into his mouth and chewing it.

June 24, 1909. Repeated experiments with monkeys.

The two Capuchins (sp. *a*), the Dent's and Mona Monkeys behaved exactly as before. They took the larvæ, smelt them, tasted them once or twice, and finally rejected them. The Capuchin (sp. *b*) which had previously eaten two, again ate one without signs of relish or the opposite. I then offered a larva to another Capuchin of the same species (*b*) and he treated it as the specimens of the species *a* and as the Mona had done, that is to say smelt it, tasted it, rubbed it in his hands, repeated the tasting once or twice, and finally dropped it. His behaviour showed that the difference between the behaviour of the first example of sp. *b*, which ate the larvæ, and that of the examples of sp. *a*, which rejected them, is not attributable to the specific distinction between the Monkeys as might have been supposed, if only one specimen of sp. *b* had been available for experiment.

One given to Canadian Jay, taken, pecked, jammed into a cranny, and repeatedly pecked; then dropped. When the bird made no attempt to fetch it, the keeper picked it up and placed it on the perch, when the bird again seized it, jammed it into a cranny in the perch, and left it.

One given to Red-backed Shrike was eagerly seized, and after one or two pecks was left, the bird retiring and wiping his beak on the bars, as the Canadian Jay had also done.

Two given to Silver Pheasant were taken and pecked, and after a good deal of rubbing in the earth were eaten.

One given to Prince of Wales' Pheasant was taken, pecked and rejected.

One given to Piping Crow was pecked and tasted and rejected, after a good deal of shaking of the head and wiping of the beak on the part of the bird. It was then picked up by a Magpie, which after a taste or two stowed it away under a large stone, and built up the hole with pebbles.

One given to Buff Laughing Kingfisher was taken and tasted, but rejected with much bill wiping. Tried and rejected in the same way by a second specimen of this bird.

One given to Common Laughing Kingfisher was taken and tasted, but finally rejected.

One given to Dial Bird was finally rejected after a great deal of pecking and tasting, accompanied by much shaking of the head and wiping of the bill.

One given to White-collared Crow was taken, tasted, carried about, and finally dropped. This bird refused to take a second specimen offered immediately afterwards.

One given to Hooded Crow was treated in exactly the same way as the one above-mentioned was treated by the White-collared Crow. This Hooded Crow also refused a second specimen.

One given to Wild Turkey was taken and pecked, but soon rejected.

Seven-spotted Ladybird (*Coccinella 7-punctata*).

July 5, 1909. I offered one to the Capuchin which was the only one of these Monkeys to eat the *Timarcha*-larvæ, thinking he might be deficient in tasting powers. He took it at once from my fingers into his mouth, and crushed it between his teeth; but, presumably as soon as he got the flavour, removed it from his tongue with his fingers, and took no further notice of it.

I offered the remains to a Mona Monkey, but she only smelt them and pulled them to pieces, and would not taste them.

July 23 to 31, 1909. One was offered the Capuchin (sp. *a*) that had eaten the *Euchelia jacobææ* and *Bombus lapidarius* on the previous day, and had so far refused nothing in the way of Lepidoptera. He took it from my hands directly, transferred it to his mouth and crushed it; but instantly took it from his tongue, wiped it on the perch and left it without a second look. I then gave the crushed insect to the Meerkat that had eaten *E. jacobææ* and the *Bombus lapidarius*. He seized it at once, but just as promptly spat it out, gave his mouth a wipe with his paw, and never attempted a second taste.

One given to Vervet Monkey which had just eaten a *Timarcha tenebricosa* (see p. 842). She took it, smelt, licked and examined it thoroughly, rubbed it between her hands, then dropped it to the floor and took no further notice of it. I had previously offered this *Coccinella* to a Chacma Baboon. She smelt it but would not take it from my fingers.

One given to the Capuchin which on a previous occasion had tasted and rejected one. He took it, and after a great deal of smelling, tasting, rubbing between his hands and on the boards of the cage, finally ate it bit by bit, pulling it into many little pieces. This Capuchin had just before eaten a *Carabus violaceus*.

One smelt but refused by three Meerkats. Grabbed by Yellow Meerkat, tasted, but let go unhurt. Taken by Banded Mongoose, and eaten after much rubbing in the sawdust, and with many shakes of the head.

One offered to Grey Lemur, was smelt, taken in the hand and dropped.

Sept. 20, 1910. One taken and quickly eaten by Meerkat; but the same animal refused a second specimen.

One taken and rubbed about in the sand and repeatedly bitten,

and ultimately eaten by another Meerkat, but the same animal refused a second.

One taken in the paws by a Marsh Mongoose, but rejected after being repeatedly rubbed in the sand and smelt.

One taken by Banded Mongoose and crushed, but rejected with much head-shaking; swallowed by a second animal also with much head-shaking.

One refused after being smelt by three Yellow Meerkats.

One taken and licked by Capuchin, but rejected.

One licked but rejected by Red-handed Marmoset.

Another monkey of same species, and a Common Marmoset refused even to taste it.

July 23, 1909. One examined by Spectacled Thrush, but not touched. Pecked by Fantailed Flycatcher, which shook his head and left it. The bird returned three times, however, and pecked the beetle, but finally gave it up. I then offered it to a Shama three times in succession, and upon each occasion he flicked it away and made no attempt to follow it up. Next I tried the Harmonious Shrike-Thrush. He took it, and after a good deal of pecking, ate it.

July 31, 1909. Three eaten in succession by cock Silver Pheasant. The first one he took from my hand, but put it out of his beak on to the ground. After one or two pecks, however, he swallowed it. The others he took from my fingers and bolted entire as if they were grain, exactly as he had previously bolted the beetles, *Pterostichus niger* and *Ocypus olens*.

Sept. 20, 1910. One taken by Pearl-spotted Owl, but dropped at once.

One taken by a Pekin Robin, which after a few pecks and head shakes left it and took a drink of water; tasted by another bird of the same kind, but also left uneaten.

One taken and swallowed, after a deal of pecking about in the sand and head shaking, by another specimen of Pekin Robin, which had just previously eaten the grasshopper (*Stenobothrus*) and the bug (*Therapha hyocyami*).

One given to the Dial Bird that had just eaten a Humble Bee (*Bombus agrorum*). He took it at once, and after a little delay swallowed it whole.

N.B. This is the bird that rejected the two White Butterflies (*Pieris brassicæ* and *napi*) after tasting them.

One taken but rejected by Masked Wood-Swallow; then taken and eaten by Shama.

Two taken and bolted quickly by the same Shama, which showed no signs of objecting to the taste, except a single shake of the head on each occasion after swallowing the beetle.

Although some of these beetles were eaten both by mammals and birds, there can be no doubt that they were distasteful to the majority of the animals to which they were offered, even to some of those that ate them.

The interest of the demonstration of the distastefulness of *Coccinella 7-punctata* lies in the fact that Coccinellidæ of various kinds are mimicked in the tropics by insects of other orders, as well as by spiders.

Order **HEMIPTERA.**

Olive-brown Bug (*Tropicoris rufipes*).

July 21, 1909. One (dead) given to Mona Monkey was eaten after a great deal of handling, smelling and tasting.

One put on the ground was tackled by Fantailed Flycatcher, which pecked it some half dozen times. He was then driven off by a hen Black Tanager, which pecked it and pecked it again, and then left it. A Syrian Bulbul then flew up and tried it, but after persevering for some little time gave it up. Then the Tanager had another attempt, but left it. I then gave the mangled remains to the Harmonious Shrike-Thrush, and after a little pecking about he swallowed them.

One (living) eaten with very little delay by Silver Pheasant; but put on the ground after being taken from my hand. This specimen was immature on arrival; it moulted in the box, and was apparently adult when given to the bird.

One (dead) treated in the same way and eaten by the same bird.

Red and Black Bug (*Therapha hyocyami*).

Sept. 20, 1910. One given to Pekin Robin was at once taken and ultimately eaten; but the bird took a long time over it, putting it on the ground after each peck and vigorously shaking his head before tasting it again. The behaviour of this bird was exactly the same towards *Coccinella 7-punctata* (p. 846).

Order **DIPTERA.**

Bombus-like Fly (*Volucella bombylans*).

July 26, 1909. One taken by Fantailed Flycatcher but after being pecked and pulled about for some time, was left. The Sulphury Tyrant then tried it, but also left it alone after much pecking. Finally it was taken by Spectacled Thrush, which ate it after much pecking and wiping in the sand.

One given to Black-headed Sibia was eaten after a great deal of pecking and breaking up.

These experiments, as Dr. Longstaff reminded me, suggest that this fly is, at all events to a certain extent, unpalatable. If future tests should prove it to be so, its likeness to *Bombus* will be an instance of Müllerian rather than of Batesian Mimicry.

See also below, pp. 854–855.

Bombus-like Fly (*Arctophila mussitans*).

See below, pp. 851 and 853.

Fly like a small Bombus (*Chilosia illustrata*).

See below, pp. 854–855.

Spiny Fly (*Echinomyia ferox*).

July 31, 1909. One (dead) taken by female Tanager, but after a good deal of pecking, was left. A Black-headed Sibia then tried it and finally ate it.

One also eaten by Sulphury Tyrant (see below, p. 855).

Daddy Long-legs (*Tipula oleracea*).

Oct. 26, 1909. One taken from my hand and eaten readily by Dial Bird; one taken and eaten, but not so readily, by a second Dial Bird; one eaten greedily by Fantailed Flycatcher.

One of these specimens of Tipula was taken twice by the Harmonious Shrike-Thrush, but was dropped on both occasions. Another was taken three times by Black-winged Grackle, but was not eaten.

The rejection of this insect by the Shrike-Thrush, which ate almost every insect other birds refused, was very surprising.

Fly (*Empis tessellata*).

July 31, 1909. Two (dead). Eaten greedily by the Dent's Monkey that took the *Thanaos tages* with avidity (p. 831).

Order **HYMENOPTERA**.

Tipula-like Ichneumonid (*Ophion luteus*).
(Nocturnal species, mahogany-red in colour, with very tough integument.)

Oct. 26, 1909. One taken and tried perseveringly by Fantailed Flycatcher, but ultimately abandoned. Also tried but soon given up by Yellow-crowned Hangnest; taken and after a little pulling about swallowed entire by Dial Bird.

Nov. 7, 1909.—Taken by Black-winged Grackle; but so hard was the insect that it shot away out of his beak. The bird pounced on it at once on the sandy floor of the aviary and ate it; but if the insect had not been very lethargic, or if it had fallen amongst the undergrowth, it might have escaped him. Hence probably the significance of its hard slippery exoskeleton.

Larvæ of Saw-fly (*Cladius viminalis*).

These larvæ were yellow with black spots. They were sent to me by Mr. Taylor.

Aug. 19, 1910. Refused without tasting by Yellow-crowned Hangnest, Crested Bulbul, Blue-bird, and Fantailed Flycatcher.

Tasted but rejected by Black-winged Grackle, Harmonious Shrike-Thrush, Black-chinned Laughing Thrush, and Green Toucanet.

Taken by Greater Spotted Woodpecker, placed in a hole in a stump and hammered, but ultimately flicked away and lost.

Two taken and eaten after much pecking and tasting by a Shama. One eaten fairly readily by a Dial Bird; but another bird of the same species rejected a specimen after tasting and flicking it from his beak about twenty times.

Wood-Ant (*Formica rufa*).

May, 1910. Taken and eaten with avidity by the following birds:—Pearl-spotted Owl; Orange-headed Ground-Thrush; Dial Bird; Shama; Black-headed Sibia; Blue-bird; Pekin Robin; Harmonious Shrike-Thrush; Spotted Oriole; Larger Hill Mynah; Black-winged Grackle; Yellow-crowned Hangnest; Greater Spotted Woodpecker.

A Capuchin Monkey also ate one after another, picking them up in his hands and gobbling them as fast as possible.

Several specimens thrown into a cage containing three Wall Lizards were tasted by two of them, but rejected at once without being damaged in any way by the tasting.

Most of the birds showed no signs of objecting to the taste of the ants, or even of perceiving anything peculiar in their flavour. The Pearl-spotted Owl, however, shook his head, and the Spotted Oriole wiped his beak on the perch after eating them. The Pekin Robin and the Black-winged Grackle wiped the ants upon their wings, presumably to remove the formic acid. It is interesting to find the same device practised by two species so unlike one another.

I found that the birds, like the monkey, would eat as many of these ants as were given to them.

The unavoidable conclusion that these insects are palatable is rather surprising in view of the frequency with which ants of different kinds are mimicked in the tropics by Orthoptera, Coleoptera, and other insects, as well as by spiders. Nevertheless, it corroborates the opinion put forward by McCook and amplified and endorsed by myself in 1909 *, before these experiments were made, that ant-mimicry is mainly serviceable as a protection against the predatory Hymenoptera of the family Pompilidæ, which provision their nests with Arthropoda of various kinds, excepting ants, and are certainly the direst enemies that spiders possess.

* Journ. Linn. Soc., Zool. xxx. pp. 265–268.

Saw-fly (*Allantus arenatus*).

July 21, 1909. One eaten by Mona Monkey fairly readily; by Capuchins readily; by the Capuchin which on the previous day had refused the Malacoderm Beetle (*Rhagonyche fulva*); smelt, but not tasted by Lion Marmoset.

One eaten fairly readily by Harmonious Shrike-Thrush; by Shama readily; by Silver Pheasant; refused without tasting by Wild Turkey.

Honey-bee (*Apis mellifica*). (Workers.)

May 8, 1911. One offered to Silver Pheasant was taken from the forceps but immediately flicked away; the bird persevered, however, and after much pecking and flicking about of the insect, and wiping his bill on the ground, finally ate it.

One offered to Bornean Fire-backed Pheasant was inspected carefully but rejected untasted.

One given to Pekin Robin was taken at once, but was quickly flicked away. When pursued, however, by other birds in the cage, the Pekin Robin pounced on the bee again and flew away with it. Whenever he got a moment's peace, he put it on the ground, pecked and flicked it about, wiping it now and again in the sand and repeatedly shaking his head. At length he flew to a branch, and holding the bee against it with his foot, pulled it in two pieces, dropping one piece to the ground. He still persevered with the other piece, however, but I finally lost sight of him and do not know whether he ate it or not.

One given to a Cayenne Tanager was taken and chewed for a long time; the remains, however, were finally jammed into a banana and left.

One taken by a Blue Tanager which, however, allowed himself to be robbed without resistance or flight by a Maroon Tanager. This bird, after a deal of mastication, ate the bee.

One given to Wall Lizard was eagerly seized, but was left after one or two attempts.

Another was twice darted at by another lizard of this species, but was left alone the moment the lizard touched it. It was then boldly seized by a third lizard, which with one bite disabled the bee by crushing the head and thorax. This lizard persevered for about seven minutes, biting at the bee, but stopping after each bite to lick his mouth with his tongue and rub it against the moss. Finally he gave it up and went away.

Two Bluebottles (*Calliphora vomitoria*) and a Hover-fly (*Syrphus*) given as a check experiment were seized and eaten in a few seconds by the same lizards.

Humble Bee (*Bombus agrorum*).

(See also *infra*, p. 853.)

Oct. 26, 1909. One eaten with avidity by Capuchin and by Meerkat.

One given to Collared Jay-Thrush, which pecked it about and scraped it in the sand for a long time, wiping his beak in the intervals, and ultimately left it. It was then picked up by a White-crested Jay-Thrush, which treated it for some time in the same way, but at last ate the mangled remains. This same bird then took a specimen of the mimetic fly *Arctophila mussitans*, but made just the same fuss over the eating of it as he had in the case of the bee.

Sept. 18, 1910. One taken at once by Dial Bird, and after a good deal of pulling about, pecking and wiping in the sand, was eaten. This bird had just previously eaten a small Tortoiseshell Butterfly, and he took about the same time to finish off the one insect as the other.

Sept. 20, 1910. One offered to Dial Bird was taken at once and eaten with very little delay, after being wiped once or twice in the sand. The bird flew away with a second specimen and I did not see what became of it; but he returned to me, and I had difficulty in keeping him away from the bees with which I was experimenting with other birds.

This Dial Bird was the one that ate the same species of Humble Bee two days previously.

Humble Bee (*Bombus ? joncellus*).

July 31, 1909. One offered alive to Mona Monkey was snatched at once and eaten bit by bit.

Humble Bee (*Bombus ? terrestris*).

July 31, 1909. One (dead) taken by Brazilian Hangnest and pecked to pieces, the bird holding it the while in his foot against the perch. The pieces pecked off were dropped about the cage and not eaten.

Humble Bee (*Bombus lapidarius*).

May 31, 1909. One dead specimen given to the Meerkat was eaten bit by bit, after being rubbed in the sawdust by the animal's paws.

One dead specimen given to Capuchin (*Cebus* sp. *a*) was taken in the hands and eaten bit by bit, just as the Monkey would eat a piece of hard biscuit or sugar. Neither of these mammals showed any signs of disliking the taste of the bees; quite the contrary. Their molar teeth are evidently much better adapted for crushing the chitinous exoskeletons than are the beaks of the birds that tasted them.

One dead specimen offered to Syrian Bulbul was taken after about a minute's inspection. The bird pecked it and pulled it about for at least five minutes and dodged away with it from other birds that chased him. He grew, however, less and less

keen, and ultimately allowed a female Black Tanager to rob him of it. The Tanager behaved in just the same way, pecking and pulling it about and breaking it to pieces, but gradually losing her interest. At last she picked up a piece of the thorax and flew to a bush with it, leaving the remainder on the ground. I could not see what became of the piece she flew away with, but she emerged from the bush without it, and wiped her beak on a perch. She made no attempt to go back to the bits on the ground. A Sibia tried these, but after a peck or two left them, and no other insectivorous bird in that compartment took the least notice of them. So I picked up the abdomen and gave it to the Harmonious Shrike-Thrush which had just finished off the example of *B. hortorum*, mentioned below, and he ultimately ate it after a great deal of pecking and pulling about.

Humble Bee (*Bombus hortorum*).

May 31, 1909. One living example fell to the ground of the aviary when first liberated. Two Fantailed Flycatchers flew down to it at once, but although interested would not touch it; while they were hesitating the bee took wing and escaped, none of the birds in the aviary making any attempt at pursuit.

One dead specimen offered to a Shama. She allowed me to hold it close to her beak, but would not touch it. None of the other birds in the aviary would notice it when thrown to the ground, though on a previous occasion they had shown great eagerness in seizing dead butterflies. I then gave it through the bars to the Harmonious Shrike-Thrush in the next compartment. After pecking and pulling it about for six or seven minutes, he ultimately ate it.

July 31, 1909. One sniffed at but rejected by two Meerkats; taken by a third and eaten.

One pecked and flicked away by Black-headed Sibia, by Shama and also by Sun-Bittern, each making two or three attempts. Then carried off by female Black Tanager, but dropped to the floor, where a North American Cat-bird tried it once or twice, but gave it up. (The remains were now too mangled to be useful for further experiment.)

I could not induce the Fantailed Flycatcher to take any notice of this bee.

Conclusion. These experiments indicate that the Humble Bees used for the tests were much more palatable to the mammals than to the birds. With the exception of the one example of *B. lapidarius* which was smelt and left untouched by two Meerkats, all the bees offered to the Monkeys and Meerkats were eaten without any kind of dislike of the flavour being evinced. The Meerkat that rubbed the *B. lapidarius* in the sawdust did so, I suspect, to remove some substance offensive to his sense of smell. On the other hand, of the birds to which the bees were offered only three

ate them, namely a Dial Bird, a Jay-Thrush, and a Shrike-Thrush. The Dial Bird ate one quickly with only one or two wipes in the sand. In the other cases there was a great deal of pecking and wiping before the insects were finally disposed of. From the behaviour of the birds there could be no doubt that there was something in the bees not to their liking, even to those that ultimately ate them. The Bulbul, Sibia, and Tanager were obviously keen to eat them, and gave them the fullest possible trial before finally rejecting them; but whether it was the hairs, or the hard chitin, or the flavour, or a combination of them that made the insects unpalatable, I do not know.

Further experiments demonstrating the distastefulness of Humble Bees to birds of different kinds are given in the following section:—

Experiments to test the significance of the resemblance between Humble Bees (*Bombus*) and the Flies *Arctophila mussitans*, *Volucella bombylans*, and *Chilosia illustrata*.

Bombus agrorum and *Arctophila mussitans*.

Oct. 26, 1909. Offered Bee to a Lion Marmoset which was busily catching house-flies and bluebottles in his cage. He looked at it, but would not touch it. I then offered the fly, but he also refused to touch it. He did not, however, hesitate to take a Red Admiral offered a moment afterwards.

Offered Bee to Leach's Laughing Kingfisher. He took it at once, but soon flicked it away. Six times in succession he took it from my fingers and dropped it on each occasion. I could not induce him to take it again. Instead he started pecking my fingers. Thereupon I offered him the fly, and he just as resolutely refused to take it.

Offered Bee to Kagu, a New Caledonian Rail. He inspected it, and after a little hesitation tasted it. But he would not touch it again; and when offered the fly, refused that likewise.

Offered Bee to Central American White-browed Partridge. He took it without hesitation, but after a peck or two left it and went away. I then threw it to him, and he tasted it again; but would not eat it. I then threw him the fly, but he would not touch it.

A Douracouli (a South-American monkey); a Honduras Turkey; a cock and a hen Reeves's Pheasant, and three hen Silver Pheasants refused to touch both bee and fly, though they inspected them intently for a few seconds.

Sept. 20, 1910. Bee offered to Hoopoe was taken at once and tasted without being crushed, but was then left on the ground uneaten. The bird refused the next one I offered, and then refused to take the fly, although he stretched his head towards it and inspected it.

Bee offered to Yellow-crowned Hangnest, which took it at once, but soon dropped it. A second time he took it, and dropped it.

The third time it was offered he refused it, and immediately afterwards refused the fly.

Bee offered to Sulphury Tyrant. I importuned the bird into taking it from my fingers no fewer than eight times, and each time he flicked it away. The ninth time he refused to take it, and then refused the fly.

Bee offered to Black-winged Grackle, which took it at once, but dropped it. Twice more he took it and the last time flew a short distance away and persevered with it for about three-quarters of a minute, then leaving it returned to me; he refused the next bee I offered, and then refused the fly.

Bee offered to Silver Pheasant was at once taken, put on the ground, pecked and crushed almost past recognition, but left uneaten. The bird then took from my fingers three more specimens in succession, but dropped them uncrushed from his beak at once. The fifth he looked at, but would not touch, and then also refused the fly after inspecting it.

The experiments described above with the Lion Marmoset, the Douracouli, the Turkey, and the Reeves's and Silver Pheasants, which would not touch either the bee or the fly after some seconds of intent inspection, do not prove that the bee was known to be distasteful, and that the fly was rejected in consequence. That may be the explanation. The Douracouli, however, is nocturnal and probably does not naturally feed upon diurnal-flying insects. In the case of the Marmoset, the experiment does, however, suggest very forcibly that the *Arctophila* was not recognised as closely allied to the bluebottles the animal was hunting. The other experiments speak for themselves.

Bombus hortorum, *Volucella bombylans*, and *Chilosia illustrata*.

July 31, 1909. Offered living *Bombus hortorum* to the Brazilian Hangnest that had just pulled the dead *Bombus terrestris* to pieces. He took it directly, but instantly flicked it away and wiped his beak. The bee then crawled up the bars of the cage, and he again pecked and flicked it away. It was now too injured to crawl although still alive, so I picked it up and offered it in my fingers. He took it again and flicked it away. Twice more the trial was made, with the same result, although he was patently tiring of the trials. The next time he refused to touch it after inspection. I then substituted a dead *Volucella bombylans*. He inspected it, but did not touch it, and hopped up to the top perch.

I then offered the nearly dead *Bombus* to another specimen of the same bird. He took it from my fingers three times in succession, and each time flicked it away. The fourth time he refused to touch it. I then substituted the same specimen of *Volucella bombylans*, but after looking at it he would not take it.

I then again offered the *Bombus* to the first Hangnest. He took it and flicked it away, and immediately afterwards refused to touch the *Volucella*.

Next day I offered the first Hangnest a *Bombus* again; he took it from me three times, and flicked it away without attempting to eat it, but immediately afterwards took *Chilosia illustrata* and ate it.

The second Hangnest took a dead *Bombus*, and flicked it away, and then ate *Chilosia illustrata*, but refused immediately afterwards to touch a live *Bombus hortorum*.

Offered *Bombus hortorum* to North American Cat-bird, which came up to me on seeing other birds being fed. He pecked it several times, but flicked it away and gave it up. During the next quarter of an hour I could not induce him to touch either *Volucella bombylans* or *Chilosia illustrata*.

I then offered the *Bombus* on the forceps to a Sulphury Tyrant. He pecked and flicked it away several times, then left it, and refused it when offered again. I then offered him the *Volucella bombylans* both in the forceps and by throwing it to him on the ground, but he would not touch it. After a little hesitation, however, he took an *Echinomyia ferox* from the forceps and ate it, and then took and ate *Chilosia illustrata*. I then offered him *Bombus hortorum* again, and he took it but soon rejected it, and immediately afterwards refused to touch *Volucella bombylans*.

One *Bombus hortorum* offered to a Shama, which pecked it once or twice, and flicked it away each time. He then refused to touch the specimen of *Volucella bombylans*.

Tried the experiment with another Shama, which behaved in exactly the same way towards the bee, and would not afterwards touch the *Volucella bombylans*.

One *Bombus hortorum* offered to Silver Pheasant was taken at once, but left after some pecking and tasting. Then without hesitation he took *Chilosia illustrata* from the forceps and ate it; and promptly tried the *Bombus* again as it lay on the ground, but would not eat it. Immediately afterwards he eagerly ate an *Ocypus olens* and three specimens of *Pterostichus* (see pp. 837–838).

I made one *Volucella bombylans* do duty for all the experiments described above and had it intact at the end. It was not pecked by any of the birds, presumably because I never offered it to one until he had tried *Bombus hortorum* a sufficient number of times to reject it as unpalatable; and there is no doubt in my opinion that they did not distinguish between the bee and the fly. Although *Chilosia illustrata* is also very like *Bombus*, the difference in size is well marked. I suspect that in this circumstance lies the explanation of the birds not confusing this species of fly with the bee. They could judge the difference in size quite easily, because the insects were held at the same distance from them.

List of the Mammals, Birds, and Reptiles used for the Experiments.

MAMMALS.

Mona Monkey (*Cercopithecus mona*), Nigeria. Diana Monkey (*Cercopithecus roloway*), Gold Coast and Guinea. Dent's Monkey (*Cercopithecus denti*), Ituri Forest. Vervet Monkey (*Cercopithecus pygerythrus*), Cape Colony. Yellow Baboon (*Papio sphinx*), Nigeria. Ceylonese Macaque (*Macacus pileatus*), Ceylon.

Although feeding mostly upon fruits, roots, and vegetables of various kinds, all the Monkeys of the Old World eat insects as well.

Capuchins (*Cebus*, spp. ?).

Several immature specimens, belonging to undetermined species inhabiting the forests of the northern parts of South America.

Douracouli (*Nyctipithecus trivirgatus*).

A nocturnal Monkey from the Amazons.

Lion Marmoset (*Leontocebus rosalia*). Pinché Marmoset (*Leontocebus œdipus*). Red-handed Marmoset (*Leontocebus rufimanus*). Common Marmoset (*Callithrix jacchus*).

Although vegetable feeders in the main, the South American Monkeys and Marmosets seem more addicted to an insect diet than the Monkeys of the Old World.

Grey Lemur (*Hapalemur griseus*). Crowned Lemur (*Lemur coronatus*). Black Lemur (*Lemur macaco*). White-fronted Lemur (*Lemur fulvus albifrons*). Mongoose Lemur (*Lemur mongoz*).

Lemurs inhabit Madagascar. They do not appear to be partial to insects.

Suricate or Meerkat (*Suricata suricatta*).

Cape Colony. Feeds on small animals of various kinds and particularly insects and their grubs (*W. L. Sclater*).

Yellow Meerkat (*Cynictis penicillata*).

Cape Colony. Feeds on small birds, mammals, eggs, and insects (*W. L. Sclater*).

Banded Mongoose (*Crossarchus fasciatus*).

South and East Africa. Feeds on insects, fruits, seeds, eggs, snails, etc., according to Böhm.

Common Indian Mongoose (*Mungos mungo*), from India, and McCarthy's Mongoose (*Mungos fulvescens*), from Ceylon, live on small mammals, birds, reptiles, insects, and fruit. The White-tailed Mongoose (*Mungos albicauda*), from Africa south of the

Sahara, does not, so far as is known, differ in diet from the other species just mentioned.

Marsh Mongoose (*Mungos galera*).

West and South Africa. An amphibious species feeding mainly it is alleged upon crabs, fishes, frogs, and insects.

Grison (*Grison furax* = *Galictis vittata*).

A musteline carnivore from the Argentine, feeding upon small mammals and birds but also fond of fruit.

Common Armadillo (*Dasypus villosus*).

Argentine. Feeds on insects, grubs, worms, carrion, and vegetable matter.

BIRDS.

Cape Robin-chat (*Cossypha caffra*).

Range. East Africa to Cape Colony.
Food. Chiefly insects, spiders, and worms; also berries and small fruit (*Sclater & Stark*).

Common Thrush (*Turdus musicus*).

Range. Palæarctic Region, locally migratory.
Food. Insects, worms, fruit, etc.

Orange-headed Ground-Thrush (*Geocichla citrina*).

Range. The Himalayas up to 5000–6000 ft., Assam and Tenasserim.

Blue Rock-Thrush (*Geocichla* (*Monticola*) *cyanus*).

Range. From South Europe and North Africa to Turkestan, Tibet, the Himalayas, and Burma.

Common Rock-Thrush (*Geocichla* (*Monticola*) *saxatilis*).

Range. C. & S. Europe to C. Asia, N.E. Siberia and N. China.

Wood-Thrush (*Hylocichla mustelina*).

Range. Eastern North America, Central America to Guatemala.

Dial Bird (*Copsychus saularis*).

Range. Ceylon, India, ascending the Himalayas up to 5000 ft.; Burma and Tenasserim.

Shama (*Cittocincla macrura*).

Range. Ceylon, India and Burma.

Blue-bird (*Sialia sialis*).

Range. Eastern North America to a little west of the Missouri River.
Food. Insects of various kinds; also ripe fruits.

American Cat-bird (*Galeoscoptes carolinensis*).

Range. South-eastern United States to the Missouri, migrating southwards in the winter.
Food. Insects, fruit and seeds.

Mocking Bird (*Mimus polyglottus*).

Range. Southern United States from the Atlantic to the high central plains; locally migratory.

Food. Insects and fruit.

Cuban Mocking Bird (*Mimus orpheus*).

Range. Jamaica, Porto Rico, Haiti, Cuba.

Saturnine Mocking Bird (*Mimus saturninus*).

Range. Brazil.

Great Tit (*Parus major*).

Range. Widely distributed in the Palæarctic Region. Locally migrating but mostly resident.

Food. Insects and seeds.

Pekin Robin (*Liothrix luteus*).

Range. Himalayas from Simla to Bhutan; extending also into China; resident.

According to E. W. Oates the food of this bird consists of berries, fruit, seeds, and insects.

Pied Grallina (*Grallina australis*).

Range. Australia, generally distributed.

Food. Insects (*Gould*).

White-eared Bulbul (*Pycnonotus leuconotus*).

Range. Persia; Sind, the Punjab, the N.W. Provinces of India, and Central India as far east as Hoshargabad.

White-cheeked Bulbul (*Pycnonotus leucogenys*).

Range. Afghanistan; the Himalayas from Murree to Bhutan, up to 7000 ft.

Red-vented Bulbul (*Pycnonotus hæmorrhous*).

Range. Ceylon; India roughly to the foot of the Himalayas.

According to E. W. Oates the Indian species of Bulbuls feed chiefly upon fruit.

Syrian Bulbul (*Pycnonotus xanthopygus*).

Range. N.E. Africa, Arabia, Palestine, Cyprus.

Black-crested Bulbul (*Otocompsa flaviventris*).

Range. Nepal to Cochin China.

In the course of my experiments I noticed that Bulbuls of different species were very keen on butterflies; of beetles and crawling insects generally they took little if any notice; but the moment a butterfly was let loose in the aviary they were all on the move. From this I infer that they are great butterfly-hunters in their own countries.

Orange-headed Laughing Thrush (*Trochalopteron erythrocephalum*).

Range. Himalayas, from Chamba to Nepal up to 7000 ft.

Black-chinned Laughing Thrush (*Trochalopteron nigrimentum*).

Range. Himalayas from Nepal to Assam (7000 ft.).

According to E. W. Oates the food of the Laughing Thrushes (*Trochalopteron*) is the same as that of the Jay-Thrushes (*Garrulax*).

Spectacled or Melodious Jay-Thrush (*Trochalopteron canorum*).

Range. China; Shanghai, Amoy, Fokien, Chekiang.

Black-headed Sibia (*Sibia capistrata*).

Range. Himalayas from Hazára to Bhutan, 5000–8000 ft.; resident.

Collared Jay-Thrush (*Garrulax picticollis*).

Range. China: Chekiang, Fokien.

White-crested Jay-Thrush (*Garrulax leucolophus*).

Range. Himalayas to Assam and Burma in the hill-tracts.

According to E. W. Oates the Indian species of *Garrulax* feed upon every sort of insect and smaller reptiles, and probably also on fruit.

Grey Struthidea (*Struthidea cinerea*).

Range. South-eastern Australia; resident.
Food. Insects, particularly beetles.

Spotted Oriole (*Oriolus maculatus*).

Range. Sumatra, Java, Borneo.

Harmonious Shrike-Thrush (*Collyriocincla harmonica*).

Range. Australia; N. S. Wales and S. Australia.
Food. Insects (*Gould*).

White-eyebrowed Wood-Swallow (*Artamus superciliosus*).

Range. Interior of South Australia.
Food. Insects (*Gould*).

Masked Wood-Swallow (*Artamus personatus*).

Range. South Australia, locally migratory.
Food. Insects (*Gould*).

Red-backed Shrike (*Lanius collurio*).

Range. Europe, migrating in the autumn and winter into Western India and to South Africa.
Food. Insects; small birds etc.

Fantailed Flycatcher (*Rhipidura tricolor*).

Range. Australia, widely distributed.
Food. Insects of various kinds (*Gould*).

Garrulous Honey-eater (*Myzantha garrula*).

Range. South Australia, Tasmania.
Food. Honey and insects (*Gould*).

Black Tanager (*Tachyphonus melaleucus*).

Range. Costa Rica through Panama, Venezuela, Ecuador to Bahia.

Scarlet Tanager (*Rhamphocœlus brasilius*).

Range. South-eastern Brazil.

Cayenne Tanager (*Calliste cayana*).

Range. Guiana, Venezuela, Ecuador, Peru.

Green Hangnest (*Ostinops viridis*).

Range. Guiana, Brazil, Ecuador.

Yellow Hangnest (*Cassicus persicus*).

Range. Trinidad, Guiana, Ecuador, Bolivia, Brazil.

Common Hangnest (*Icterus vulgaris*).

Range. Colombia, Venezuela.

Brazilian Hangnest (*Icterus jamaicai*).

Range. North Brazil.

Yellow-crowned Hangnest (*Icterus chrysocephalus*).

Range. Guiana, Venezuela, Ecuador, Brazil.

Larger Hill Mynah (*Gracula intermedia*).

Range. India: the south-eastern Central Provinces, the lower ranges of the Himalayas from Kumaon to Assam, thence into the Malay Peninsula.

Small Hill Mynah (*Gracula religiosa*).

Range. Ceylon and Southern India.

According to E. W. Oates these two species of Mynah are resident or only locally migratory and live exclusively upon fruit.

Chinese Mynah (*Acridotheres cristatellus*).

Range. China: Shanghai, Hainan, Formosa; Philippine Islands.

Pied Mynah (*Sturnopastor contra*).

Range. Central and South India to Assam and Burma.

Javan Pied Mynah (*Sturnopastor jallœ*).

Range. Sumatra, Java, Borneo.

Black-winged Grackle (*Graculipica melanoptera*).

Range. Java.

Spotted Bower Bird (*Chlamydodera maculata*).

Range. New South Wales.
Food. Principally fruit and grain (*Gould*).

King Bird of Paradise (*Cicinnurus regius*).

Range. New Guinea.
Food. Fruit and insects.

Canadian Jay (*Perisoreus canadensis*).

Range. Canada and the Northern States of the Union.
Food. Insects; eggs, flesh; leaves of fir trees (*Audubon*).

Hooded Crow (*Corvus cornix*).

Range. Palæarctic Region.
Food. Omnivorous (eggs, carrion, young birds, etc.).

White-collared or Pied Crow (*Corvus scapulatus*).

Range. Africa south of the Sahara.
Food. Omnivorous, with partiality for flesh food.

White-backed Piping Crow (*Gymnorhina leuconota*).

Range. S. Australia, New South Wales.
Food. Mostly insects (*Gould*).

Long-billed Butcher Crow (*Cracticus destructor*).

Range. Australia.
Food. Chiefly insects.

Sulphury Tyrant (*Pitangus sulphuratus*).

Range. Guiana, Ecuador, Peru, Brazil.
Food. Mostly insects and animal food of various kinds as well as fruit.

Greater Spotted Woodpecker (*Dendrocopus major*).

Range. Palæarctic Region.
Food. Insects.

Common Laughing Kingfisher (*Dacelo gigantea*).

Range. New South Wales and South Australia.

Leach's Laughing Kingfisher (*Dacelo leachii*).

Range. North-east coast of Australia.

Buff Laughing Kingfisher (*Dacelo cervina*).

Range. East and North Australia.
Food. These great Kingfishers feed mainly upon reptiles and insects, but also upon rats and mice.

Elate Hornbill (*Ceratogymna elata*) and
Black Hornbill (*C. atrata*).

Range. W. Africa, Nigeria, etc.
Food. Insects; snakes, small mammals, etc.

Ground Hornbill (*Bucorax abyssinicus*).

Range. North Africa south of the Sahara.

Food. Insects, snakes, frogs, lizards (Stark and Sclater writing of the closely allied southern species *B. caffer*).

Hoopoe (*Upupa epops*).

Range. Southern Palæarctic Region from Scandinavia and the British Islands to Japan, migrating in winter to North Africa, Arabia and India.

Food. Ground insects, beetles, grasshoppers and ants.

Cartagenian Motmot (*Momotus subrufescens*).

Range. From Panama, Colombia, and Venezuela to Matto Grosso.

Great Barbet (*Megalæma virens*).

Range. China and Upper Burma.

Levaillant's Barbet (*Trachyphonus caffer*).

Range. S. Africa, Natal, the Transvaal, Rhodesia, etc.

Food. Fruits, berries, leaves, and insects such as termites (*Stark & Sclater*).

Green Toucanet (*Aulacorhamphus sulcatus*).

Range. Venezuela; Colombia.

Pearl-spotted Owl (*Glaucidium perlatum*).

Range. Africa south of the Sahara.

Food. Mostly insects (grasshoppers, termites); also mice and lizards (*W. L. Sclater*).

White-eared Scops Owl (*Scops leucotis*).

Range. Africa south of the Sahara to the Orange River.

Food. Chiefly insects, like grasshoppers; also rats and mice (*W. L. Sclater*).

Prince of Wales Pheasant (*Phasianus principalis*).

Range. North-western Afghanistan and North-east Persia.

Reeves's Pheasant (*Phasianus reevesii*).

Range. Mountains of Northern and Western China, extending as far east as Kiu-Kiang.

Elliot's Pheasant (*Calophasis ellioti*).

Range. Mountains of South-eastern China.

Silver Pheasant (*Gennæus nycthemerus*).

Range. South China, Fokien and Chekiang.

Vulturine Guinea Fowl (*Acryllium vulturinum*).

Range. East Africa from the Pangani River westwards to Kilimanjaro and northwards to Somaliland.

Pucheran's Guinea Fowl (*Guttera pucherani*).

Range. East Africa: Zanzibar to the Tana River and thence westwards into the interior.

N. American Wild Turkey (*Meleagris americana*).

Range. Formerly widely distributed in the United States of America. Not migratory.

Food. Beechnuts, acorns, berries, green-shoots, etc.; also grasshoppers, and other insects (*Bendire*).

Honduras Turkey (*Meleagris ocellata*).

Range. Central America: Guatemala, Yucatan, Honduras.

Food. Probably of a similar nature to that of *M. americana*.

Long-tailed Partridge (*Dendrortyx leucophrys*).

Range. Highlands of Guatemala and Costa Rica (*Ogilvie-Grant*).

Brush Turkey (*Catheturus lathami*).

Range. North-east and East Australia.

Crested Curassow (*Crax alector*).

Range. Northern part of South America: British Guiana, Colombia, Rio Negro, etc.

Globose Curassow (*Crax globicera*).

Range. Central America: Western Mexico to Honduras and Cozumel Island.

Yarrell's Curassow (*Crax carunculata*).

Range. South-eastern Brazil from Rio Janeiro to Bahia.

Red-tailed Guan (*Ortalis ruficauda*).

Range. Venezuela and the island of Tobago.

Most Game-birds, especially when young, eat insects as well as grain, nuts, and green-food.

Australian Bustard (*Eupodotis australis*).

Range. South and Western Australia.

Food. Seeds, vegetables, grasses, and insects (*Gould*).

Vigors's Bustard (*Otis vigorsii*).

Range. S. Africa: Cape Colony, Natal, etc.

Food. Seeds, insects, small reptiles (*Stark & Sclater*).

Ludwig's Bustard (*Otis ludwigi*).

Range. S. Africa: Cape Colony, Natal, Orange River Colony, S. Transvaal; partially migratory within this area.

Food. Mostly beetles, caterpillars, and other insects (*Stark & Sclater*).

The food of Bustards is probably much the same everywhere. The diet is essentially mixed, and consists of grain, green-shoots and leaves insects, small mammals (mice) and reptiles.

Two-striped Thickknee (*Œdicnemus bistriatus*).

Range. Mexico through Central America to Venezuela
Food. Insects, worms, snails, etc.

Trumpeter (*Psophia crepitans*).

Range. Brazil.
Food. Fruits, seeds, insects.

Cariama or Seriema (*Cariama cristata*).

Range. South-east Brazil.
Food. Reptiles and small mammals for the most part.

Abbott's Rail (*Rallus abbotti*).

Range. Assumption Island.

Black-tailed Water-hen (*Tribonyx ventralis*).

Range. Australia, south of the 25th parallel; locally migratory.

Kagu (*Rhinochætus jubatus*).

Range. New Caledonia.

Sun-Bittern (*Eurypyga helias*).

Range. Northern countries of the Neotropical Region.
Food. Mostly insects.

REPTILIA

The Green Lizard (*Lacerta viridis*), from Central and Southern Europe; the Wall Lizard (*Lacerta muralis*), from Central and Southern Europe; the Filfola Wall Lizard (*L. muralis filfolensis*), from Filfola, near Malta; Dugès's Lizard (*Lacerta dugesii*), from Madeira; the Sand Lizard (*Lacerta agilis*), from North and Central Europe; and the Black-spotted Lizard (*Algiroides nigropunctatus*), from Dalmatia, feed mainly upon insects, worms, and small slugs.

Glass Snake (*Ophisaurus apus*).

South-eastern Europe. Feeds on small mammals, reptiles, slugs, etc.

Notes upon some of the above described Experiments by
Prof. E. B. Poulton, F.R.S., F.Z.S.

Pages 815–820.

The experiments on the *Pierinæ* support the conclusion that the perfection of the under surface procryptic resemblance affords a true criterion of the degree of palatability.

P. brassicæ, with its conspicuous gregarious larva, and imago larger and less cryptically coloured than the other three species

(although nearly the same as *P. rapæ* in this respect), was distinctly the least palatable of the four. On the other hand, *P. napi* and *E. cardamines*, in which the cryptic resemblance is carried to its highest pitch, appeared to be most palatable; but a larger number of experiments is greatly to be desired.

The results obtained in the two former species are of much interest in relation to the experiments upon *Melanargia galathea* (p. 827).

Pages 820–822.

The evidence that *V. urticæ* is not very palatable agrees with my own experiments * with a Marmoset; and I obtained the same results with *V. io* when offered in considerable numbers to lizards. It is probable that the procryptic under surface of the Vanessas is chiefly related to the attacks of mammals and of very hungry birds during the long hibernating period. The special interest in the eye-spots of *V. io* manifested by the Syrian Bulbul, accords with previous observations on other insects and other insect-eaters, Reptilian as well as Avian †.

Pages 823-825.

The evidence of a certain amount of unpalatability in *Brenthis* (Argynnidæ) is consistent with the degree of procryptic defence attained in this genus. It is also of much interest in connexion with the experiments on *Araschnia levana*, the early or *levana* form of which is probably a mimic of the species of *Brenthis*. The examples of the *Araschnia* tested by the author (pp. 823–824) were of the form *prorsa*, belonging to the later brood, and generally looked upon as mimics of the White Admiral (*Limenitis sibylla*), which appears upon the wing at about the same period. The experiments here recorded prove that the mimic is certainly unpalatable to several birds, and support the conclusion that the resemblance is Müllerian or Synaposematic. The evidence, so far as it goes, points indeed to the inference that *Araschnia* is more unpalatable than its *Brenthis* model. A few experiments on the imago of *L. sibylla* made by Mr. Pocock in the summer of 1910, also indicated that the *prorsa* form is more unpalatable than the *Limenitis*. There is, however, nothing improbable in a Müllerian mimic being more highly protected than its model. The rôle of model is related to many characteristics, and relative abundance, conspicuousness, and extent of range may play their part as well as relative unpalatability. Thus it is probable, from its habits and flight, that the Eastern European *Neptis lucilla*, W.V. (=*sappho* Pall.) is more distasteful than its *Limenitis* models, but the latter are widespread and abundant species, and it is reasonable to suppose that the memories of European insect-eating animals are more deeply impressed by their pattern than by that of the *Neptis*.

* Trans. Ent. Soc. Lond. 1902, p. 442.

† 'Essays on Evolution' (Poulton), 1908, p. 210: see also p. 326.

Pages 825–827.

The desirability of experiments upon the palatability of the genus *Melitæa* was suggested by the study in 1908 of a collection of butterflies from the Tian Shan or Celestial Mountains in Western Mongolia. Small as it was, the collection was sufficient to show that *Melitæa* is a dominant element in the insect fauna of the locality. The large "Skipper," *Hesperia antonia* Spey, was also abundantly represented, and I was at once struck with the marked resemblance which its under surface would bear in the position of rest to that of the species of *Melitæa*. The striking feature of the latter genus is supplied by two black-bordered orange bands which cross the hind wings and stand out conspicuously against the cream ground-colour. These two bands, the outer with its festooned, the inner with its irregular borders, present a highly characteristic appearance. The small portion of the fore wing under surface exposed in the position of rest conforms, as is usual in butterflies, to the pattern of the hind and appears as a slight extension of its area. In spite of differences in detail, the two orange bands of the Hesperid closely resemble those of *Melitæa*, and in all essential respects the exposed under surface of the former reproduces that of the latter. In the Skipper the outer margin of the outer band is cut into internervular concavities, while the inner bulges into corresponding convexities: in the Nymphaline, concavities are seen along both borders. The orange of the bands and the tint of the ground-colour—white between the bands, greyish elsewhere—are also much paler in the Skipper, but the orange pigment is probably quite different from that of *Melitæa* and may rapidly fade. It is also interesting to note that the orange bands of the under surface are represented by black bands on the upper surface of the Skipper but by orange bands on that of the Nymphaline. The allied *Hesperia sidæ* Esp., with golden bands, is doubtless a co-mimic with *H. antonia*, while in a third closely related species, *H. carthami* Hübn., the dark bands have gained a bronzy greenish or yellowish tinge, probably indicating the kind of variation out of which the pattern of the two first-named species was produced by selection.

Probable evidence that *Melitæa* is a specially protected genus is supplied by the well-known habits of the three British species *aurinia* (=*artemis*) Rott., *cinxia* L., and *athalia* Rott. All are known to be gregarious in the larval state, and so abundant in confined localities that they may be described as gregarious in the perfect state also. All are slow-flying and conspicuous on the wing and at rest between the flights, while individuals have been observed to "sham death" when captured. Putting all the facts together, it appeared probable that we have an interesting addition to the list of mimics among the Palæarctic butterflies, a list which is remarkably short in the western section of the Region. Mr. Pocock kindly consented to test the hypothesis that *Melitæa* possesses the distasteful qualities of a model for mimicry, and Commander J. J. Walker kindly helped to obtain material for

the experiments which are recorded on pp. 825–827. The results as a whole leave little doubt that *Melitæa* is distasteful to many birds, and that it does actually possess the qualities which would render it an advantageous model for the Hesperiidæ.

Pages 827–830.

The experiments on *Melanargia galathea* are of peculiar interest. The northern belt Satyrinæ of this genus, with their white ground-colour, stand out from the rest of their group. The under surfaces are conspicuous, the species slow-flying and so abundant locally that they may be called gregarious. The observations here recorded show that they are also distinguished by their greater distastefulness from other common northern Satyrines. The appearance of the species of *Melanargia*, especially on the wing, is markedly Pierine-like, and it is here also probable that a highly distasteful genus has mimicked an assemblage of species which, although generally less unpalatable, are excessively widespread and abundant in individuals (see also p. 865).

Pages 830–831.

The experiments upon Lycænidæ, Nemeobiinæ, and Hesperiidæ were not sufficiently numerous to form the foundation for safe conclusions.

Pages 831–855.

The remaining experiments, for the most part, afford valuable confirmation of previous work, but they also raise new questions of great interest. Confirmation is afforded by the evident unpalatability of *Zygæna*, *Euchelia*, and *Abraxas* among the moths, of the Saw-fly larvæ, of the Telephoridæ, Phytophaga, and Coccinellidæ among the beetles, and of the Hemiptera, as also by the special and peculiar defensive secretions of the Carabidæ and, in sharp contrast to all these observations, by the palatability of the procryptically coloured moths and larvæ.

Pages 847–848.

The apparent distastefulness of the humble-bee-like *Volucella bombylans* suggests conclusions of so much importance and interest that abundant confirmation is essential, and should be readily available with so common a species.

Pages 848–852.

Experimental evidence that the Aculeate Hymenoptera possess some special defence independently of the stings of the females is now obtained for the first time. It was suggested as probable by the present writer in 1904, as a result of the observation that the males of the bee *Sphecodes* emerge in immense numbers and form complex mimetic associations, before the appearance of the females, as also from the consideration that the Braconidæ are extensively mimicked*.

* Trans. Ent. Soc. Lond. 1904, pp. 645–6.

Page 849.

Although so many insectivorous animals in confinement disregarded the special defence of *Formica rufa*, there can be little doubt that such defence is very effective in the wild state. It is impossible on any other hypothesis to account for the conditions under which the species exists—swarming in vast numbers in restricted areas and an easy prey to any enemy that would dare to attack.

A very important conclusion is suggested by several of the experiments recorded in this memoir, namely, that the tastes of mammals and birds are widely different. The author points out that the defence of the ground-beetles appealed more strongly to the mammals than to the birds, but it was also apparent in many of the experiments that the unpalatability of conspicuous Lepidoptera was, conversely, far more obvious to the birds than to the mammals. In view of the part which birds are believed to play in the production of mimetic resemblance, it is obvious that this inference may be highly significant.

ADDENDUM.

Dr. P. Chalmers Mitchell's Memoir "On Longevity and Relative Viability in Mammals and Birds," P. Z. S. 1911, p. 425.

[The Rev. F. C. R. Jourdain has kindly called my attention to the fact that I have overlooked a valuable paper "On the Duration of Life of the Animals in the Zoological Garden at Frankfort-on-the-Main," by Director Dr. Max Schmidt, P. Z. S. 1880, p. 299, and containing many valuable figures as to longevity].—*P. C. M., Aug. 2, 1911.*